

## **APPENDIX F-5**

### **Qualitative Analysis Paper**

#### **Bycatch**

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## ACRONYMS AND ABBREVIATIONS

ABC	acceptable biological catch
ADF&G	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center
AFA	American Fisheries Act
BSAI	Bering Straits/Aleutian Islands
CDQ	Community Development Quota
Council	North Pacific Fisheries Management Council
ESA	Endangered Species Act
EFH	Essential Fish Habitat
EEZ	Exclusive Economic Zone
EFPs	experimental fishing permits
ft	feet
FMP	Fishery Management Plan
GOA	Gulf of Alaska
IR/IU	improved retention/improved utilization
IFQ	Individual Fishing Quota
IPHC	International Pacific Halibut Commission
lbs	pounds
MSA	Magnuson-Stevens Fishery conservation and Management Act
MRB	maximum retainable bycatch
mt	metric tons
nm	nautical miles
NMFS	National Marine Fisheries Service
PSC	prohibited species catch
SCA	Stellar Sea Lion Conservation Area
TAC	Total Allowable Catch

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# BYCATCH

## 1.0 Introduction

The principal goal of the North Pacific Fisheries Management Council (Council) is to maximize the benefits of North Pacific groundfish resources for the overall good of the people and the environment. Council decisions are based upon a number of biological and socioeconomic considerations all of which must be weighed when determining management and conservation strategies. A core objective of the Council is to maximize the sustainable yield of the groundfish fishery at minimal cost, while at the same time ensuring that targeted stocks remain stable and robust over time. Management policies must also act in conjunction with other conservation goals such as the protection of marine mammals, seabirds, and Essential Fish Habitat (EFH). Socioeconomic considerations include the effects that groundfish management policies might have on other domestic and subsistence fisheries of the Pacific northwest. Amid all of these concerns, the Council must also comply with one of the major policy goals of the Magnuson-Stevens Fishery Conservation and Management Act (MSA): to develop practical measures that minimize bycatch and avoid unnecessary waste of fish.

Bycatch is defined as fish which are harvested in a fishery but which are not sold or kept for personal use. It is that portion of the catch that is discarded back into the sea. Bycatch includes species that must be returned to the sea by law (regulatory discards), and fish that are discarded at the discretion of the fisherman because they are not economically worthwhile to keep (economic discards). Bycatch also includes fishing mortality due to encounters with fishing gear (unobserved fishing mortality). Fish taken as bycatch often suffer high mortality and discards are considered a loss both environmentally and economically. Many of the species that are protected under Fishery Management Plan (FMP) amendments that limit bycatch are the targets of other domestic and subsistence fisheries in Alaska. Excessive bycatch mortality in the groundfish fishery could affect the viability of these other domestic fisheries and the people and economies that depend on them. However, bycatch restrictions place greater economic burdens on the groundfish industry either by limiting fishing or reducing fishing efficiency. Compliance with time/area closures and bycatch release standards can require considerable expenditures of time and effort on the part of the fisherman.

Mortality is a key consideration when assessing measures that might minimize bycatch. If all discards could safely be returned to the sea unharmed, bycatch would be less of a conservation issue and higher levels of bycatch would be acceptable. In some instances, mortality other than that attributable to fish being taken aboard ship is taken into account when establishing management policy. Crabs typically suffer little mortality when taken aboard a fishing vessel as bycatch relative to other sources of crab mortality such as the directed crab fishery. However, trawl fishing can harm sensitive crab habitat thereby potentially inflicting "unseen" mortality on the population. If bycatch mortality is excessive, the economic impact to the target fishery may be completely discounted and the fishery prohibited; e.g., there is a total ban on the use of seines and gillnets in the groundfish fishery because of their indiscriminate bycatch. On the other hand, if bycatch mortality is nominal, the fishery may be allowed to operate in a less restrictive and more economically-efficient atmosphere. In general, FMP policy attempts to minimize bycatch mortality while at the same time minimizing economic hardships to a number of different, and sometimes competing, fisheries.

This paper provides a broad qualitative overview of four proposed management policies as they pertain to the regulation of bycatch in the North Pacific groundfish fishery of the Bering Straits/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) regions. Its goal is to provide the reader with a basic understanding of each potential policy and the biological, physical, and socioeconomic consequences of each alternative. It also identifies information gaps or other shortcomings that may impede specific components within any of the proposed alternatives.

## 2.0 Historical Perspective on Bycatch

Management of bycatch in the North Pacific groundfish fishery has historically focused on halibut, herring, salmon, and crabs (Table 1). Prior to 1976, the groundfish fishery in the BSAI and GOA management regions were essentially unregulated and most fishing was conducted by foreign fleets. The MSA of 1976 established an Exclusive Economic Zone (EEZ) extending some 200 miles off U.S. shores and fishing within this area fell under U.S. jurisdiction. Following passage of the MSA, preliminary FMPs established management measures to reduce bycatch by these foreign fleets. Measures included time and area closures; prohibitions on the retention of halibut, crabs, salmon, herring, and shrimp (prohibited species catch [PSC]); the establishment of a limited observer program; and restrictions on the use of bottom trawls. By the early 1980s, bycatch control measures were also being directed at the burgeoning domestic groundfish fishery. For the first time in the GOA, domestic trawlers had bycatch limits placed on halibut, which, when reached, prohibited fishing with other than off-bottom trawls.

By 1985, the presence of foreign fishing fleets within the EEZ had greatly diminished, and management attention began to focus on the rapidly developing joint-venture fisheries and the completely domestic groundfish fisheries. Bycatch limits were applied to domestic fisheries operating throughout the GOA although it wasn't until later that these limits were mandated for the BSAI. Additional measures to reduce bycatch included requiring biodegradable panels on sablefish pots, and that observers be present on all joint-venture process vessels.

From 1986-1990, major policy emphasis was placed on reducing bycatch of PSC in the domestic fishery. Extensive time and area closures were implemented around Kodiak Island and the eastern Bering Sea to protect red king crab. Bycatch limits were set for halibut, red king crab, and bairdi Tanner crab. In 1990, a bycatch limit was placed on herring for the trawl fleet. Bycatch limits were applied to the entire domestic fishing fleet based upon area, season, and fishery sector. PSC restrictions closed down the fishery on several occasions.

By 1991, the groundfish fisheries were fully domestic. From 1991-1995, PSC bycatch reduction continued to be a major policy goal. Restrictions were placed on the construction and use of fishing gear to minimize the bycatch of both PSC species and juvenile components of target groundfish stocks. Other restrictions included a prohibition on the use of seine and gillnets, minimum mesh size for all trawls, a blanket requirement for biodegradable panels and halibut excluder devices on all groundfish pots, and careful release mechanisms for the longline fishery. In the Bering Sea, PSC limits were established for chum salmon and additional areas were closed to protect red king crab. A herring PSC limit was established for the BSAI trawl fishery. Halibut bycatch limits were redefined in terms of mortality instead of just total bycatch.

Since 1995, conservation efforts to reduce bycatch and waste in the groundfish fishery have continued. Recent years have seen additional closures in the Bristol Bay area to protect red king crab. PSC limits were established for opilio Tanner crab and Chinook salmon, and revised for red king and bairdi Tanner crabs. The pollock fishery was restricted to the use of off-bottom trawls only, and a complete ban was placed on any direct fishery for forage fish. Retention and utilization programs have been revised and improved. In addition to maintaining and modifying bycatch limits on the PSC species (halibut, crabs, salmon, herring), the Council established, under specific condition, bycatch restrictions on a number of other species including those species directly targeted in the North Pacific groundfish fishery (detailed below).



**Table 1**                      **Chronology of management measures to control bycatch of prohibited species in the groundfish fisheries of the BSAI and GOA, 1935-2000.**

Effective Year	Management Action
1935	Trawls prohibited except for shrimp and flounder fishing in BSAI.
1937	Use of dynamite prohibited in BSAI.
1938	Use of gillnets prohibited for catching halibut in BSAI.
1942	Trawls permitted except for salmon and herring fishing in BSAI.
1944	Use of trawls prohibited for catching halibut in BSAI.
1948	Five-inch minimum mesh size required for trawls in BSAI.
1959	Trawls prohibited for taking any crab species in BSAI. Trawling prohibited in Bristol Bay and king crab pot sanctuary in BSAI
1967	Halibut nursery area closed to halibut fishing in BSAI. Foreign fisheries prohibited around Fox Islands in BSAI.
1969	Pribilof Islands area closed to foreign fishing.
1972	Pot gear prohibited for catching halibut in BSAI.
1973	Use of tangle nets prohibited for catching crab in BSAI.
1974	Catch quotas established for Japanese groundfish fisheries limited effort for BSAI pollock and flatfish and GOA Pacific ocean perch and sablefish.
1975	Catch quotas established for USSR groundfish fisheries in BSAI.
1976	Magnuson-Stevens Act passed, providing national standards and regulations for managing federal fisheries to 200 miles.
1977	Preliminary groundfish FMPs implemented with groundfish optimum yields; closures of foreign fisheries when any one species limit is attained; several closure areas in BSAI and GOA extended from bilateral agreements; prohibited status for halibut, salmon, crabs, and shrimp.
1979	GOA FMP implemented with no retention of prohibited species (salmonids, halibut, shrimp, herring, crab, scallops); expansion of time-area closures to reduce halibut expansion of time-area closures to reduce halibut of TALFF taken December 1 to May 31 to minimize halibut bycatch; domestic trawlers restricted by halibut PSC limits for five areas for December 1-May 31; halibut and Tanner crab PSC limits for domestic fishermen included; depth restrictions on use of foreign longlines seaward of 500 m May 1-September 30 to minimize bycatch of halibut. Created new species OY for grenadiers (rattails) to protect them from bycatch (since rescinded, GOA-5). Pacific cod TALFF allocated to foreign longlines around Chirikov to reduce bycatch of other species, permitted directed longlining for Pacific cod to reduce halibut bycatch, required foreign vessel operators to report bycatch and discard of salmon and halibut.
1980	Set OY and four species categories, required biodegradable panels on sablefish pots to minimize bycatch of small sablefish, and established four species categories (target, PSC, unallocated, other) (GOA-8).
1982	BSAI FMP implemented with specific management objective to rebuild halibut; established PSC category for halibut, salmon, crabs; expanded time-area closures for foreign fisheries to reduce bycatch of juvenile halibut, set bycatch policy for domestic fishermen; set target observer coverage in foreign fisheries at 35-40 percent. Set chinook PSC of 65,000fish for foreign trawl fishery (BSAI-1a). Closed waters east of 140 °W to West (GOA-10). Prohibited pot longline gear for sablefish, partially to eliminate ghostfishing (GOA-12).
1983	PSC bycatch reduction schedule established for BSAI foreign trawl fishery, allowed domestic trawling in pot sanctuary and halibut savings area in BSAI, set 1986 goal of 17,473 salmon (BSAI-3). Closed GOA southeast to foreign trawl fisheries to protect halibut, allowed foreign longlines to fish shallower than 500 m in winter halibut savings area, until halibut bycatch reached 105 mt.

**Table 1 (Cont).****Chronology of management measures to control bycatch of prohibited species in the groundfish fisheries of the BSAI and GOA, 1935-2000.**

<b>Effective Year</b>	<b>Management Action</b>
1984	Set BSAI groundfish OY cap at 2 million mt, allowed domestic trawling in winter halibut savings area with observers and Bristol Bay pot sanctuary until halibut PSC limit is reached (BSAI-7). Raised halibut PSC to 270 mt in western GOA and 768 mt in central GOA and exempted domestic pelagic trawl fishery from halibut PSC limit.
1985	Set BSAI salmon PSC at 27,957 salmon (26,000 chinook) (BSAI-8). Established reporting requirements and directed fishing definitions (BSAI-9, GOA-14). Revised OYs and implemented framework for setting and revising halibut PSC limits (GOA-14).
1987	PSC bycatch limits and zones established in BSAI domestic and JV flatfish trawl fisheries, set Bristol Bay trawl closure area (Area 512) to all trawling year-round, allowed RD discretion to set target species as PSC once TAC is reached (BSAI-10). Established four red King crab bottom trawl closed areas during February 15-June 15 around Kodiak Island to protect crab, revised Oys, implemented framework for setting and revising PSC limits, revised reporting requirements (GOA-15).
1988	Began pilot observer program in Dutch Harbor and Kodiak, revised ABC definition (BSAI-11). Added steelhead and salmon to PSC list and established target, other, and nonspecified categories, required 30-day comment period for annual specifications and PSC limits (BSAI-11a/GOA-16).
1989	Required weekly reporting, established PSC limits for foreign and JV fisheries, set limits on retention of bycatch after target fishery closes (BSAI-12/GOA-17). Area 516 closed to trawling seasonally during crab molting period. Endorsed voluntary herring bycatch plan. Adopted policy on full utilization of BSAI and GOA groundfish.
1990	Established crab and halibut PSC limits (BSAI-12a). New observer program, data reporting system, and directed fishing standards implemented (BSAI-13/GOA-18). Pot, jig, hand, and troll gear exempted from GOA halibut PSC limits.
1991	Prohibited pollock roe-stripping as wasteful (BSAI-14/GOA-19). Allowed seasonal apportionment of PSC limits, established vessel incentive program to reduce bycatch rates of red king crab and halibut bycatch, refined overfishing, specification process and fishing gear definitions (BSAI-16/GOA-21). Established herring savings areas and hotspot authority (BSAI-16a). Season for BSAI yellowfin sole fishery changed to May 1. BSAI flatfish fisheries delayed to May 1 to reduce halibut and crab bycatch.
1992	Regional Administrator authorized to approve experimental fishing permits to reduce bycatch (BSAI-17/GOA-22). Established time and area closures for bycatch reduction, delayed rockfish trawl opening to Monday closest to July 1 to reduce salmon bycatch and groundfish trawl fisheries to January 20 to reduce salmon and halibut bycatch, expanded VIP for all trawl fisheries and GOA, halibut PSC limits established for BSAI non-trawl fisheries, and redefined VIP and PSC limits in GOA (BSAI-19/GOA-24).
1993	Gillnets and seines prohibited for groundfish fishing in BSAI. Careful release requirements established for halibut bycatch in groundfish longline fisheries in BSAI and GOA, halibut PSC limit set at 3,755 mt for halibut trawl fishery with regulatory framework for revisions (BSAI-21). Crab bycatch performance standards set for pelagic trawl fishery in BSAI. Kodiak Island crab protection zones made permanent (GOA-26). Set performance-based pelagic trawl definition in BSAI and GOA. Established a separate species category for Atka mackerel (GOA-31).
1994	Council adopts minimum mesh-size requirements for trawl codends used in pollock, cod, and rock sole fisheries in BSAI. NMFS published vessel specific bycatch rates on the Internet, required observers to monitor salmon discards, eliminated primary halibut PSC but kept 3,775 mt trawl limit (BSAI-25). Gillnets and seines prohibited.
1995	Halibut and sablefish IFQ program implemented (BSAI-15/GOA-20). BSAI chum salmon savings area, chinook salmon savings area, red king crab savings area, and Pribilof Islands Halibut Conservation Area established to protect crabs (BSAI-21a; 21b; 35). Established minimum trawl mesh size in BSAI. BSAI jig gear exempted from halibut PSC.

**Table 1 (Cont).                      Chronology of management measures to control bycatch of prohibited species in the groundfish fisheries of the BSAI and GOA, 1935-2000.**

Effective Year	Management Action
1996	BSAI Red King Crab Savings Area permanently established as year-round trawl closure area. Voluntary salmon donation program implemented to reduce bycatch and waste (BSAI-26/GOA-29).
1997	Nearshore Bristol Bay closed to all trawling year-round. PSC limits for red king crab and bairdi Tanner crab reduced and for opilio Tanner crab implemented (BSAI-37; 41). Over-fishing definitions implemented (BSAI-44/GOA-44).
1998	Established PSC limits for opilio Tanner crab in trawl fisheries and opilio Tanner crab bycatch limitation zone (BSAI-40). Improved retention/improved utilization program implemented for pollock and cod (BSAI-49/GOA-49). Prohibited species donation program redefined to include halibut (BSAI-50/GOA-50). Forage fish category and ban on fishing implemented (BSAI-36/GOA-39).
1999	Revised overfishing definitions implemented (BSAI-56/GOA-56).
2000	Bottom trawl ban in BSAI pollock fisheries (BSAI-57). Chinook salmon PSC limits reduced to 29,000 fish in four years (pending) (BSAI-58). GOA demersal shelf rockfish full retention to account for bycatch (pending). Sponge and coral identified as HAPC-biota types under prohibited species category in BSAI and GOA (pending).

Notes: BSAI - Bering Sea and Aleutian Islands  
FMP - Fishery Management Plan  
GOA - Gulf of Alaska  
HAPC - Habitat areas of particular concern  
JV - Joint venture  
OY - Optimum yield  
PSC - Prohibited species catch  
TAC - Total allowable catch  
TALFF - Total allowable level of foreign fishing  
USSR - Union of Soviet Socialist Republics  
VIP - Vessel Incentive Program  
mt - Metric tons

### **3.0 Species Categories Management Tools**

The management of bycatch in the North Pacific groundfish fishery involves a number mechanisms that contribute to an integrated, and at times complex, regulatory framework for implementing the overall policy objectives of the Council. Fishing restrictions such as harvest quotas and gear constraints may vary over time and space in response to population shifts, migratory patterns, and life-cycle characteristics of individual species or species complexes. When sufficient scientific information is available, bycatch measures may be applied to individual species within the BSAI and GOA. In cases where little is understood about the life-history and ecology of particular species, groups of species may be managed as a single complex. The following section provides a breakdown of two major bycatch management elements; 1) the five principal species management categories, and 2) the major tools that the Council uses to manage bycatch within those species categories.

#### **3.1 Species Categories**

FMP policy is based on four species management categories: target species, prohibited species, forage species, and other species. All species not listed in one of these categories are placed, by default, into a fifth category designated as nonspecific species (Table 2).

##### **3.1.1 Target Species**

Target species are those fish that are harvested in the directed North Pacific groundfish fishery. The Council may manage target species as individual species or species groups depending upon the commercial importance of a species and the amount of biological information that is available with which to manage each species or species complex. Species such as pollock, Pacific cod and yellowfin sole are managed as distinct species in both the BSAI and GOA. In the BSAI, pollock are further managed as three regionally distinct stocks (BSAI and Bogoslof District). In contrast, the numerous species of rockfish in the GOA are managed as individual species (e.g., Pacific ocean perch) or as several species complexes the makeup of which may change from year to year.

##### **3.1.2 Prohibited Species**

Prohibited species is an FMP designation for non-groundfish species that are harvested in other domestic fisheries. Listed prohibited species include several species of king and tanner crabs, Pacific halibut, Pacific herring, steelhead trout, and the five species of Pacific salmon. Directed fisheries for these species are not directly managed by the Council. Directed fisheries for these species are managed by a number of state, federal and/or international agencies or commissions.

##### **3.1.3 Forage Species**

Forage fish play a central role in the North Pacific Ocean food chain, being consumed by a wide variety of fish, marine mammals, and seabirds. This category includes all species in the families Osmeridae, Bathylagidae, Myctophidae, Ammodytidae, Trichodontidae, Pholidae, Stichaeidae, Gonostomidae, and euphausiid shrimps. Because of their tropic importance, the BSAI and GOA FMPs were amended to prevent the development of a directed fishery on these species.

##### **3.1.4 Other Species**

This category consists of species that are not currently important to the groundfish fishery but which might have future economic potential. This group includes sharks, skates, sculpins, squids, and octopi.

**Table 2            Taxa Listing for the Five FMP Management Categories**

Targeted Species - Harvested in the North Pacific groundfish fishery
Walleye Pollock ( <i>Theragra chalcogramma</i> ) Pacific cod ( <i>Gadus macrocephalus</i> ) Flathead sole ( <i>Hippoglossoides elassodon</i> ) Rock sole ( <i>Lepidopsetta</i> spp.; 2 species) Greenland Turbot ( <i>Reinhardtius hippoglossoides</i> ) Yellowfin sole ( <i>Limanda aspera</i> ) Arrowtooth flounder ( <i>Atheresthes stomias</i> ) Other flatfish (8 species) Sablefish ( <i>Anoploma fimbria</i> ) Rockfish (32 species of the genera <i>Sebastes</i> and <i>Sebastolobus</i> ) Atka mackerel ( <i>Pleurogrammus monopterygius</i> )
Prohibited Species - Non groundfish species targeted in other domestic fisheries
Red king crab ( <i>Paralithodes camtschaticus</i> ) Blue king crab ( <i>P. camtschaticus</i> ) Golden or brown king crab ( <i>Lithodes aequispinus</i> ) Bairdi Tanner crab ( <i>Chionoecetes bairdi</i> ) Opilio Tanner crab ©. <i>opilio</i> ) Pacific halibut ( <i>Hippoglossus stenolepis</i> ) Pacific herring ( <i>Clupea harengus pallasii</i> ) Steelhead trout ( <i>Oncorhynchus mykiss</i> ) Pink salmon ( <i>O. gorbuscha</i> ) Chum salmon ( <i>O. keta</i> ) Chinook salmon ( <i>O. tshawytscha</i> ) Sockeye salmon ( <i>O. nerka</i> ) Coho salmon ( <i>O. kisutch</i> ) Sponges and Corals
Forage Species - Important food fish for other fishes, mammals, and seabirds
Osmeridae (eulachon, capelin and other smelts) Bathylagidae (deep-sea smelts) Myctophidae (lanternfishes) Ammodytidae (Pacific sand lance) Trichodontidae (Pacific sand fish) Pholidae (gunnels) Stichaeidae (pricklebacks, warbonnets, eelblennys, cockscombs, and shannys) Gonostomidae (bristlemouths, lightfishes, and anglemouths) Euphausiid shrimps (krill)
Other Species - Non-forage species of no commercial value but with future commercial potential
Sharks Skates Sculpins Octopii Squids
Nonspecified Species - Not managed or monitored
Everything not listed above including invertebrates

### 3.1.5        Nonspecified Species

The "nonspecified" species category consists of all species not listed in the four groups above, including invertebrates. None of the species within this group are currently managed or even monitored.

## **3.2 Management Tools**

The Council employs two types of management measures for the BSAI and GOA: framework measures and conventional measures. Framework measures allow the Council to rapidly respond to biological and socioeconomic changes without amending an underlying FMP. They involve annual or seasonal adjustments such as those applied to harvest and bycatch quotas. Conventional measures are specific in application and can only be changed by formally amending an FMP. Conventional measures include permits, reporting requirements, gear restrictions, and allocations among user groups. The following provides brief descriptions of major bycatch management tools that are at the disposal of the Council.

### **3.2.1 Total Allowable Catch**

The Council sets annual total allowable catch (TAC) quotas for target species and "other" species. The TAC quota defines the total tonnage of a species that may be taken by any means among all groundfish fisheries over the calendar year. TAC quotas for target species include fish taken in both the directed fishery and as incidental catch in other fisheries. Incidental catch is the catch of a target species in a fishery other than its own. These TAC allocations can be apportioned by gear type and by season to minimize bycatch mortality. For example, seasonal apportionments of pollock TAC in the western and central GOA are intended to avoid directed fishing during periods characterized by high bycatch of salmon. Seasonal or area allocations of TAC also have the effect of directing fishing effort toward periods or areas of high target fish abundance. Harvests can be maximized while keeping bycatch levels in check.

The Council may set TACs for target species and "other" species either by individual species or species groups. The groupings are based on the commercial importance of a species or species group and the amount of biological information that is available to manage each group or species. The Council may assemble or disassemble target species groups as they see fit based upon changes in population status and available information. The "other" species category requires an FMP amendment to break out a particular species or species group from a larger grouping.

### **Prohibited Species Catch Limits**

Regulations governing the treatment of prohibited species (halibut, crab, salmon, and herring) seek to reduce bycatch mortality of these key species by banning their retention as bycatch in all direct fisheries and requiring that all fish and crab taken as bycatch be returned to the sea with a minimum of injury. In addition to the general prohibition on retention, the total seasonal bycatch of individual PSC species is limited for red king crab, bairdi and opilio Tanner crabs, Pacific halibut, Pacific salmon, Pacific herring in the BSAI, and Pacific halibut in the GOA. When a PSC limit is reached for halibut and crab, the groundfish fishery is closed for the remainder of the season even if the target groundfish quota has not been reached. For herring and salmon, PSC limits are area-and-time specific. Upon attainment of the PSC limit, certain sensitive areas of high density and/or critical habitat are closed to groundfish fishing. The area closure may be temporary, being applicable only to biologically sensitive times of the year (e.g., reproduction, molting).

### **Maximum Retainable Bycatch**

Maximum retainable bycatch (MRB) limits determine the amount of a species by weight that may be retained as bycatch. MRB is expressed as a percent of total retained catch in the fishery. MRB limits are set for forage species, select prohibited species, target species relegated to bycatch status, and "other" species groups relegated to bycatch status. The species or species group in question may be retained as bycatch up to a level determined by its individual MRB. MRB serves as a management tool that limits the rate of removal of forage species and prohibited species, and slows the rate of harvest of a target species and "other" species once TAC quotas have been reached.

## **Time/Area/Gear Restrictions**

Closure of areas and seasons to fishing for some or all gear types has been an effective method for reducing bycatch dating back to the 1970's when foreign fleets were first forbidden to fish in areas of high halibut and crab concentrations. Historically, area and seasonal closures have been implemented for selected members of the prohibited species category. Management measures have included the establishment of savings areas for herring, chinook salmon, chum salmon, and king crab, as well as permanent closures to protect crab stocks in the nearshore areas of Bristol Bay and around Kodiak Island. BSAI Amendment 57 permanently prohibits the use of non-pelagic trawl gear in the BSAI pollock fishery. In the eastern GOA, bottom trawl gear directed at the shallow water target complex (which includes pollock) is permitted until halibut mortality limits are reached. The use of bottom trawls is then prohibited for the remainder of the fishing season. Seines and gillnets are completely prohibited in the groundfish fisheries because of their excessive bycatch.

## **Gear Modifications**

Modifications in gear construction and general application can also contribute to lowering bycatch. Minimum mesh sizes allow for escapement of juvenile fishes that would otherwise be taken as bycatch. Biodegradable panels and halibut excluder devices are required on all groundfish pots. Management use of future gear restrictions is largely dependent on the development of technological innovations that can be applied to the fishery in a practical and cost-effective manner.

## **Observer Program**

Observer programs provide essential technical oversight for management of the EEZ groundfish fisheries. Observers provide estimates of total catch and species composition, which allows for inseason management of the fishery. They also collect biological data for individual species that are used in stock assessments. Observers are required aboard vessels greater than or equal to 60 feet (ft) in overall length. Vessels greater than or equal to 60 ft in overall length that use pot gear require observers during 30 percent of their fishing days. Remaining vessels are subdivided into two size categories: vessels ranging from 60 to 124 ft in overall length require observers during 30 percent of the time; vessels greater than 124 ft in length require observers 100 percent of the time. Observers are also required at shoreside processors that process more than 500 metric tons (mt) of groundfish in any single month. Processors that process 500-1,000 mt in a monthly period require 30 percent observer coverage while those that process more than 1,000 mt require observers 100 percent of the time. Vessels and processors involved in programs that use vessel specific fishing quotas, such as the Western Alaska Community Development Quota (CDQ) program or the American Fisheries Act (AFA) pollock fisheries, have additional observer requirements.

## **Improved Retention/improved Utilization**

Responding to what was considered unacceptably high levels of bycatch waste, the Council adopted an improved retention/improved utilization (IR/IU) program for all groundfish target fisheries. In 1997, 258,000 mt of groundfish were discarded in the BSAI groundfish fishery, which was equivalent to about 15 percent of the total targeted groundfish harvest. Walleye pollock, Pacific cod, rock sole, and yellowfin sole comprised approximately 76 percent of this total. In the GOA, it was estimated that pollock, cod and flatfish represented about 33 percent of discards. The IR/IU program required 100 percent retention of pollock and cod in the BSAI and GOA, regardless of how or where they were caught (BSAI and GOA Amendments 49). The measure has dramatically reduced the overall numbers of discards of pollock and cod in the groundfish fishery. In 1998, the year the amendment was implemented, the number of discards dropped dramatically from 1997 levels. In the BSAI, the discard rate for pollock dropped from 94,800 mt to 16,200 mt, and for cod, from 22,100 mt to 4,300 mt. Beginning in 2003, full retention is required for rock sole and yellowfin sole in the BSAI (BSAI Amendment 49), and for all shallow water flatfish in the GOA (GOA Amendment 49). When fully implemented, retention requirements are expected to reduce overall discard rates (all species) from about 15 percent to about 5 percent.

## **Vessel Incentive Program**

Over the years, the Council has implemented a number of incentive programs designed to promote the conservation and management of groundfish fisheries. One such program is the Individual Fishing Quota (IFQ) program (BSAI Amendment 15, GOA Amendment 20) for sablefish and halibut. The program allows qualified individuals to harvest a certain percentage of the sablefish and halibut quota. Each fisherman has a quota that can be used at anytime during the open season and allows them to set their own pace. The program's intent was to allow fishermen to be more efficient and quality conscious. Bycatch reduction was also inherent in the program. Halibut taken as bycatch in the sablefish fisheries can be retained under the yearly halibut IFQ. Some contend that the current IFQ program has not been very successful.

The voluntary Salmon Donation Program (BSAI Amendment 26, GOA Amendment 29) authorizes the distribution of Pacific salmon taken as bycatch to economically disadvantaged individuals through a sanctioned distributor. Most salmon taken as bycatch are dead when brought on board ship. Under PSC designation they must be returned to the sea. The Salmon Donation Program permits the retention of this fish for the foodbank program. While the program does not reduce bycatch, it is effective at reducing bycatch waste. FMP Amendments 50 for the BSAI and GOA expanded this program to include halibut.

## **Experimental Fishing Permits**

BSAI Amendment 17 and GOA Amendment 22 authorized the issuing of experimental fishing permits (EFPs) to persons for the purpose of obtaining information necessary to promote fishery conservation and the management of fisheries.

## **Record Keeping**

Permitted catcher vessels = 60 ft in overall length must maintain a daily fishing logbook regarding fishing activity and location (50 CFR 679.50). Catcher/processor vessels, motherships, shoreside processors and purchasing stations must maintain daily cumulative production logbooks that record information on fishing activity, haul receipt, production, and discards. Information on groundfish harvest, discard, receipt, and production are reported to National Marine Fisheries Service (NMFS), which the agency uses to manage groundfish and prohibited species quotas.

## **4.0 Policy Alternatives and Rationale**

Four bycatch policy alternatives are under consideration by the Council:

**Alternative 1 – Status Quo:** Under this alternative, the Council would continue to manage the groundfish fisheries based upon the present conservative and risk-averse strategy. This strategy assumes that fishing does result in some adverse impacts to the environment and that, as these impacts become known, mitigation measures will be developed and appropriate FMP amendments will be implemented. The approach would be to continue the current strategy which relies upon management of bycatch through seasonal allocation of TAC, geographical gear restrictions, PSC limits, IR/IU requirements, and the closing of additional areas and/or requiring additional gear restrictions in response to evidence of population declines.

**Alternative 2 – More Aggressive Harvest Strategy:** A more aggressive harvest strategy would be implemented based upon the concept that the present strategy is overly conservative and that higher harvests could be taken without threat of overfishing the target groundfish stocks. This strategy assumes that fishing at the recommended levels would have no adverse impact on the environment, except in specific cases that are generally known. Bycatch would continue to be monitored, but PSC limits would be adjusted or eliminated. If necessary, bycatch would be managed by closures of areas to selected gear types.



**Alternative 3 – More Precautionary Harvest Strategy:** This policy would seek to accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles and, where appropriate and practicable, increase habitat protection and impose additional bycatch constraints. Under this approach, additional conservation management measures would be taken as necessary to respond to social, economic or conservation needs. Additional measures would be taken if scientific evidence indicated that the fishery was negatively impacting the “environment”, not just a population of a given species. The main elements of this alternative would include development of incentive programs for reducing bycatch; encouragement of research programs to better define population estimates and appropriate bycatch limits for non-target species; and development of management measures that would “encourage” the use of gear and fishing techniques that would reduce discards.

**Alternative 4 – Extremely Precautionary Harvest Strategy:** This policy would require that the user of the resource demonstrate that the intended use would not have a detrimental effect on the environment before significant fishing could be allowed. The strategy would be to impose very restrictive conservation and management measures that would only be modified or relaxed when additional, reliable scientific information became available. It would involve a strict interpretation of the precautionary principle. Management discussions would involve and be responsive to the public, but decreased emphasis would be placed on industry and community concerns, and more emphasis would be placed on ecosystem concerns and principles, including the identification and incorporation of non-consumptive use values. The overall premise is that fishing does produce adverse impacts on the environment, but due to a lack of information and uncertainty, we know little about these impacts. With regards to bycatch, this alternative would require that bycatch mortality would be included in TAC-accounting for all target, non-target and PSC bycatch species, including unseen mortality; bycatch and PSC limits would be reduced (e.g., by 10 percent/yr for five years); fisheries having >25 percent bycatch rates would be phased out; PSC limits would be established for salmon, crab and herring in the GOA; and that stringent bycatch limits would be imposed for vulnerable, non-target species. This strategy would greatly curtail the regional groundfish fisheries until more information was obtained about the frequency and intensity of fishing impacts on the environment.

Each alternative contains two endpoints to a range of management measures that illustrate how the framework of each policy alternative could be implemented. These endpoints provide a level of detail that allows analysis and provides contrastable alternatives. They also provide a means to commit the Council action in implementing an alternative, while allowing the Council, under the MSA, the flexibility to adaptively manage the fishery through FMP amendments. The endpoints of each alternative will be referred to as FMP bookends.

The bookends are not intended to be stand-alone alternatives. Instead, once the Council chooses a policy-level alternative (and accompanying bookends), it will be committing, to the extent practicable, to devise and implement an FMP consistent with that chosen alternative. The bookends therefore establish a range of management tools from which the Council will choose when revising the FMP as well as predicting the range of potential environmental effects from the use of those management tools. This alternative structure recognizes that the resource being managed, as well as the marine ecosystem, is quite dynamic in nature and only partially understood. Examining a range of management tools and their potential effects for each policy alternative is an attempt to take into account the dynamic nature of the fisheries as a whole and to provide enough management regime flexibility in each alternative to allow the decision-makers to base decisions on the best available science. Specific Illustrative FMP measures for each Alternative are summarized in Table 3.

**Table 3 Comparative FMP Frameworks Dealing with Bycatch Issues**

	Alt. 1	Alt. 2		Alt. 3		Alt. 4	
	1	2.1	2.2	3.1	3.2	4.1	4.2
Bycatch and Incidental Catch Restrictions	PSC limits for herring, crab, halibut and salmon in BSAI, and for halibut in GOA	Eliminate PSC limits	PSC limits as for Alt. 1. Where sufficient stock status information is available, adjustable PSC limits established based on a percentage of the annual stock status	BSAI: Reduce PSC limits for herring, crab, halibut and salmon to the extent practicable (0-10%) GOA: Establish PSC limits on salmon NTE a 25,000 fish cap for Chinook and a 20,500 fish cap for other salmon; establish PSC limits on crab and herring based on biomass or other fishery data Reduce GOA halibut PSC limit 0-10% for those PSC species where annual population estimates exist, the Team will explore a mortality rate-based approach to setting limits	BSAI: Reduce PSC limits for herring, crab, halibut and salmon to the extent practicable (10-30%) GOA: Establish PSC limits on salmon NTE a 25,000 fish cap for chinook and a 20,500 fish cap for other salmon; establish PSC limits on crab and herring based on biomass or other fishery data; reduce all by 0-10% Reduce GOA halibut PSC limit 10-30% For those PSC species where annual population estimates exist, the Team will explore a mortality rate-based approach to setting limits	BSAI: Reduce PSC limits for herring, crab, salmon, halibut by 30-50%  GOA: Establish PSC limits on salmon NTE a 25,000 fish cap for Chinook and a 20,500 fish cap for other salmon; establish PSC limits on crab and herring based on biomass or other fishery data; reduce all by 30-50%  For those PSC species where annual population estimates exist, the Team will explore a mortality rate-based approach to setting limits	Prohibition on all fishing Pending Review
	IR/IU for pollock, P. cod	Repeat IR/IU	No changes from Alt. 1	No changes from Alt. 1	No changes from Alt. 1	Extend IR/IU to all target species	Prohibition on all fishing Pending Review
	Current bycatch and incidental catch restrictions	No bycatch restrictions	Same as 2.1	Review effectiveness of coop-managed PSC reduction	Incentive program for incidental catch and bycatch reduction, e.g.: (a) Individual Bycatch Quota (b) Harvest Priority (10% of TAC reserved to reward clean fishing) (c) Bycatch reduction standards established (d) Coop managed Harvest Priority (0-10% TAC or PSC reserved to reward clean fishing) (e) HMAP	Reduce bycatch:  BSAI: reduce all by 30-50% GOA: reduce all by 30-50% Bycatch limits for non-target stocks as information becomes available	Prohibition on all fishing Pending Review
	VIP (vessel incentive program)			Repeal VIP program			
	Demersal Shelf Rockfish full-retention			Control bycatch by closing hotspot areas when bycatch limits are attained			Prohibition on all fishing Pending Review
	Crab trawl closures Cook Inlet prohibition for bottom trawl	Eliminate all closure areas and no Cook Inlet trawl ban	No changes from Alt. 1	No changes from Alt. 1	Develop appropriate closure areas in GOA to address bycatch for halibut and/or crab	Establish gear closure areas and marine reserves to reduce and avoid bycatch	Prohibition on all fishing Pending Review
	Inseason bycatch, management measures:	Eliminate all inseason bycatch measures	No changes from Alt. 1	No changes from Alt. 1	Repeal MRBs and establish a system of caps and quotas	No changes from Alt. 1	No inseason mgmt measures Prohibition on all fishing Pending Review
	(a) establishment of fishing seasons for bycatch mgmt (b) herring closures for areas (not fishery)						

**Table 3 (Cont.) Comparative FMP Frameworks Dealing with Bycatch Issues**

	Alt. 1	Alt. 2		Alt. 3		Alt. 4	
	1	2.1	2.2	3.1	3.2	4.1	4.2
Gear Restrictions and Allocations	Retain existing no-trawl zones and fixed gear restrictions; Bottom trawl ban in BSAI for pollock	Eliminate all trawl closure areas and trawl and fixed gear restrictions	No changes from Alt. 1	BSAI prohibition on bottom trawl for pollock	BSAI and GOA prohibition on bottom trawl for pollock	Prohibit trawling in all fisheries that can be prosecuted with other gear types (e.g., fisheries with > 25% bycatch)	Prohibition on all fishing Pending Review
	No pot fishing in GOA for sablefish	No changes from Alt. 1	No changes from Alt. 1	No changes from Alt. 1 [PLACEHOLDER; CONTINGENT ON EFH COMMITTEE]	Restrict fishing to areas where fishing has previously been concentrated [PLACEHOLDER; CONTINGENT ON EFH COMMITTEE]	Restrict bottom trawling for flatfish to specific areas: No trawling in areas identified (previous) as MPAs	Prohibition on all fishing Pending Review
	Retain existing gear restrictions and allocations	No changes from Alt. 1	No changes from Alt. 1	No changes from Alt. 1	No changes from Alt. 1		
	Sablefish and Pacific cod allocated by gear in BSAI; sablefish allocated by gear in GOA	No changes from Alt. 1	No changes from Alt. 1	No changes from Alt. 1	No changes from Alt. 1	SEE GEAR RESTRICTIONS ABOVE	Prohibition on all fishing Pending Review
Observer Program	Fixed 0/30/100% coverage  100% for AFA & CDQ catcher boats > 60 ft and 200% for AFA & CDQ catcher processors and motherships	Repeal all observer programs except AFA and CDQ	No changes from Alt. 1	Observer coverage same as Alt. 1 or modified based on data and compliance needs, and should be scientifically-based  e.g., random placement, flexibility, variable rate	Extend to 100% > 60' CDQ & AFA to stay the same as Alt. 1  (a) 100% coverage on vessels (vessels <60' = 30% coverage) (b) 100% hauls are observed	Expand level of observer coverage	Prohibition on all fishing Pending Review

Notes: AFA - American Fisheries Act  
BSAI - Bering Sea/Aleutian Islands  
CDQ - Community Development Quota  
EFH - Essential Fish habitat  
ft - feet  
GOA - Gulf of Alaska  
IR/IU - Improved retention/improved utilization  
MPA - Marine Protected Areas  
% - percent  
PSC - Prohibited Species Catch  
TAC - Total Allowable Catch

## **5.0 Alternative 1: Continue Under the Current Risk Averse Management Policy**

Many of the management strategies established by the Council to reduce bycatch in the North Pacific groundfish fishery have centered on prohibited species and more recently forage fish species. Thirty-four BSAI and 20 GOA FMP amendments have been implemented in the past 20 years to control bycatch and associated mortality within these groups. Regulatory measures have established or modified bycatch limits, fishing seasons, gear restrictions and allocations, time and area closures, bycatch rate standards, record keeping and reporting, and observer requirements. Many of these restrictions are applied to target and "other" species once their seasonal TACs have been reached or exceeded. The direct effect of Status Quo provisions on the different species groups and management tools are detailed below.

### **5.1 Target Species**

The TACs of target species are rigorously managed by the Council and NMFS under an elaborate system of data collection, inseason management, and stock assessments. Target species are subject to bycatch limits once the seasonal TAC quota has been met. Thereafter, the species cannot be targeted but may be retained up to an MRB determined by the Council. If the harvest of a given target species on bycatch status approaches the acceptable biological catch (ABC), it then goes on prohibited species status, which bans the retention of that species for the remainder of the year. Bycatch status effectively slows the rate of fishing for the target species in question once the TAC has been reached. In 2002, the only groundfish fisheries in which seasonal TAC was reached were for pollock and Alaska plaice in the BSAI (Table 4). The only other fishery for which harvests came within 5 percent of the seasonal TAC was sablefish in the GOA.

### **5.2 Prohibited Species**

#### **Pacific Halibut**

Pacific halibut fisheries are managed by a treaty between the United States and Canada through recommendations by the International Pacific Halibut Commission (IPHC). Stock assessments are conducted by the IPHC and take all halibut removals into account, including bycatch in the groundfish fisheries. Catch and discard mortality data are provided by observers attached to the groundfishing fleet. Stock assessments are then used to allocate harvest quotas in the directed halibut fishery. Because IPHC stock management accounts for bycatch mortality, halibut quotas in the directed fishery compensate for bycatch loss in the groundfish fisheries. The halibut resource is considered quite healthy and directed harvests in recent years have been near record levels.

Halibut bycatch is controlled in the BSAI groundfish fishery using PSC limits applied to specific target fisheries. Unlike other PSC limits, which allocate total allowable bycatch, PSC limits for halibut bycatch are for mortalities only. Halibut returned live to the sea do not accrue toward the PSC limit. Most halibut taken as bycatch are juveniles, so the loss must be viewed not just as immediate tonnage, but also as fish that would have grown larger.

For the 2003 fishing season, total halibut PSC limits have been set at 3,675 mt for trawl and 900 mt for nontrawl fisheries (Table 5). Bycatch limits are apportioned by gear type and target species, and within target species, they are further apportioned by season. For example, 26 percent of the 2003 halibut PSC limit assessed to trawl fisheries operating in the BSAI will be allocated to yellowfin sole. This 26 percent is further sub-allocated among four fishing seasons. Halibut bycatch allocations essentially direct fisheries, by area or time, to regions where the highest volume or highest value target species may be harvested with minimal halibut bycatch. When any fishery exceeds its seasonal limit, the entire Bering Sea is closed for that fishery.

**Table 4 TAC Allocations and Groundfish Harvests (mt) by Target Species for the 2002 Fishing Season**

Target Fishery	2002		Percent of TAC
	TAC	Catch	
BSAI			
Pollock	1,486,100	1,486,006	100.0
Pacific Cod	200,000	184,937	92.5
Atka Mackeral	98,000	87,986	89.8
Yellowfin Sole	86,000	74,861	87.0
Rock Sole	54,000	41,621	77.1
Other Species	30,825	26,467	85.9
Pacific Ocean Perch	30,600	22,392	73.2
Flathead Sole	25,000	15,419	61.7
Greenland Turbot	16,000	5,506	34.4
Arrowtooth Flounder	16,000	4,010	25.1
Alaska Plaice	12,000	12,291	102.4
Northern Rockfish	6,760	4,010	59.3
Sablefish	4,480	1,887	42.1
Other Flatfish	3,000	2,628	87.6
Squid	1,970	784	39.8
Other Rockfish	1,037	946	91.2
Shortraker/rougheye Rockfish	1,028	573	55.7
GOA			
Pollock	58,250	50,390	86.5
Pacific Cod	44,230	40,524	91.6
Arrowtooth Flounder	38,000	20,941	55.1
Shallow Water Flatfish	20,420	6,842	33.5
Pacific Ocean Perch	13,190	11,735	89.0
Sablefish	12,820	12,246	95.5
Other Species	11,330	3,748	33.1
Rex Sole	9,470	3,009	31.8
Flathead Sole	9,280	2,108	22.7
Pelagic Shelf Rockfish	5,490	3,318	60.4
Northern Rockfish	4,980	3,335	67.0
Deep Water Flatfish	4,880	558	11.4
Thornyhead Rockfish	1,990	1,125	56.5
Shortraker/rougheye Rockfish	1,620	1,291	79.7
Other Slope Rockfish	990	771	77.9
Atka Mackeral	600	84	14.0
Demersal Rockfish	350	182	52.0

**Table 5 Prohibited species catch allocations for BSAI Fishery Management Unit, 2003. Projected crab populations are denoted parenthetically. Source: DiCosimo (2002).**

Species	Gear	PSC Limits	Fishery	Season Allowances
Halibut	Trawl	3,675 mt (mortality)	<u>Trawl</u>	
			Yellowfin sole [24%]	1/0 to 3/31 [30%] 4/1 to 5/20 [22%]
	Non-trawl	900 mt (mortality)		5/21 to 7/3 [6%] 7/14 to 12/31 [43%]
			Rocksole, other flatfish, flathead sole [21%]	1/0 to 3/31 [58%] 4/1 to 7/3 [21%] 7/4 to 12/31 [21%]
	Pot gear	exempt		
	Jig gear	exempt	Turbot, sablefish, arrowtooth [0%]	None
			Rockfish [2%]	7/4 to 12/31 [100%]
	Hook-and-line (sablefish only)	exempt	Pacific cod [39%]	None
			Pollock, Atka mackerel, other [6%]	None
			CDQ Fisheries [7%]	None
			<u>Non-trawl</u>	
			Pacific cod [86%]	1/1 to 6/10 [41%] 8/15 to 12/31 [59%]
			Other non-trawl [6%]	5/1 to 12/31
			CDQ Fisheries [7%]	None
Herring	Trawl	1,526 mt (1% of estimated biomass)	Yellowfin sole [9%]	None
			Rocksole, other flatfish, flathead sole [1%]	
			Turbot, sablefish, arrowtooth [<1%]	
			Rockfish [<1%]	
			Pacific cod [1%]	
			Pollock, Atka mackerel, other [87%]	
Red king crab (Zone 1)	Trawl	97,000 crabs	Yellowfin sole [17%]	None
			Rocksole, other flatfish, flathead sole [62%]	
			Pacific cod [12%]	
			Pollock, Atka mackerel, other [2%]	
			CDQ Fisheries [8%]	

**Table 5 (Cont.) Prohibited species catch allocations for BSAI Fishery Management Unit, 2003. Projected crab populations are denoted parenthetically. Source: DiCosimo (2002).**

Species	Gear	PSC Limits	Fishery	Season Allowances
Opilio Tanner crab (Bycatch Limitation Zone)	Trawl	4,350,000 crabs	Yellowfin sole Rocksole, other flatfish, flathead sole Turbot, sablefish, arrowtooth Rockfish Pacific cod Pollock, Atka mackerel, other CDQ Fisheries	[64%] [22%] [1%] [1%] [3%] [2%] [8%] None
Bairdi Tanner crab (Zone 1)	Trawl	980,000 crabs	Yellowfin sole Rocksole, other flatfish, flathead sole Pacific cod Pollock, Atka mackerel, other CDQ Fisheries	[35%] [37%] [19%] [2%] [8%] None
Bairdi Tanner crab (Zone 2)	Trawl	2,970,000 crabs	Yellowfin sole Rocksole, other flatfish, flathead sole Rockfish Pacific cod Pollock, Atka mackerel, other CDQ Fisheries	[60%] [20%] [<1%] [11%] [1%] [8%] None
Chinook salmon	Trawl	29,000 fish		1/1 to 4/15
Other salmon	Trawl	42,000 fish		8/15 to 10/14

In recent years halibut PSC limits for the GOA have been 2,000 mt for trawl and 300 mt for nontrawl fisheries. PSC limits in the GOA may also be allocated by season, among fisheries, and among gear types. If some gear types have excessively high bycatch mortality rates, the Council may withhold that fishery's halibut PSC limit in order to promote other gear types that might otherwise close prematurely. In both the BSAI and GOA, bycatch limits of Pacific halibut often prevents the annual TAC of many groundfish species from being harvested.

Other measures that have reduced halibut bycatch include seasonal and area allocations of TAC for selected target species, seasonal and year-round area closures, gear restrictions, careful release requirements, an IFQ vessel incentive program, public reporting of individual bycatch rates, and gear modifications. Examples of gear modifications are biodegradable panels and halibut excluder devices that are required on all groundfish pots. Implementation of the IFQ program (see Management Tools) resulted in an immediate reduction in annual PSC limits for the GOA from 750 mt to 150 mt.

### **Pacific Herring**

Directed fisheries for herring occur entirely in state waters and are managed by the Alaska Department of Fish and Game (ADF&G). Harvest quotas are determined by the Alaska Board of Fisheries and are based upon biomass forecasts as determined from landings data. Pacific herring bycatch limits (BSAI Amendment 16a) in the groundfish fisheries apply to trawl gear operating within three specified areas designated as Herring Savings Areas 1, 2, and 3, all of which are located in the Bering Sea (Figure 1). These areas are characterized by large seasonal aggregations of herring. The annual PSC limit determined by the Council is set at 1 percent of projected herring biomass and is designed to fluctuate with herring abundance as estimated for each year. For the 2003 fishing season, the herring PSC limit has been set at 1,526 mt (Table 5). This bycatch limit is also apportioned among specified trawl fisheries. If a bycatch allowance is attained for a specific fishery, that fishery is prohibited from operating in Area 1 from June 15 to July 1, in Area 2 from July 1 to August 15, and in Area 3 from September 1 through March 1. These time/area closures are designed to track seasonal herring migrations and aggregations. In the BSAI, herring bycatch occurs primarily in the pollock and yellowfin sole fisheries.

In the GOA, bycatch is rather nominal and occurs almost exclusively in the pollock fisheries; 78 percent in pelagic trawls, 12 percent in bottom trawls. Herring bycatch is estimated to be such a small percentage of total herring biomass in the GOA that there are no PSC limits or area closures designated by the Council.

### **King and Tanner Crabs**

Many of the crab stocks in the BSAI are currently at or below critical levels. The Bristol Bay red king crab population is below critical stock size and the directed fishery was closed in 1994 because of poor conditions. Conditions were so bad that a red king crab savings area was established by emergency rule in 1995, and made permanent under BSAI Amendment 37. The blue king crab population in the Pribilof Islands is considered to be low (NMFS 1998d) and population in the Saint Matthew Island area is estimated to be below minimum stock size threshold (NMFS 1999b). The stock was declared overfished and the fishery was closed in 1999. The Council considers the Bering Sea Tanner crab stock overfished and is likely that the population will continue to decline for years (Morrison *et al.* 1998).

In response to the depressed status of many crab stocks, the Council established permanent year-round closures in areas deemed to be critical crab habitat (Figure 1). These include the 19,000 nm<sup>2</sup> nearshore Bristol Bay area (BSAI Amendment 37), the 7,000 nm<sup>2</sup> Pribilof Island Habitat Conservation Area (BSAI Amendment 21a), the 4,000 nm<sup>2</sup> Red King Crab Savings Area (BSAI Amendment 37), the 1,000 nm<sup>2</sup> Red King Crab Protection Area around Kodiak Island (GOA Amendment 26), and Management Area 512 closure (BSAI Amendment 10). In 2000, the Council approved Amendment 60 which permanently prohibits nonpelagic trawling in a 7,000 nm<sup>2</sup> area of Cook Inlet that is considered critical habitat for depressed king and Tanner crab stocks.



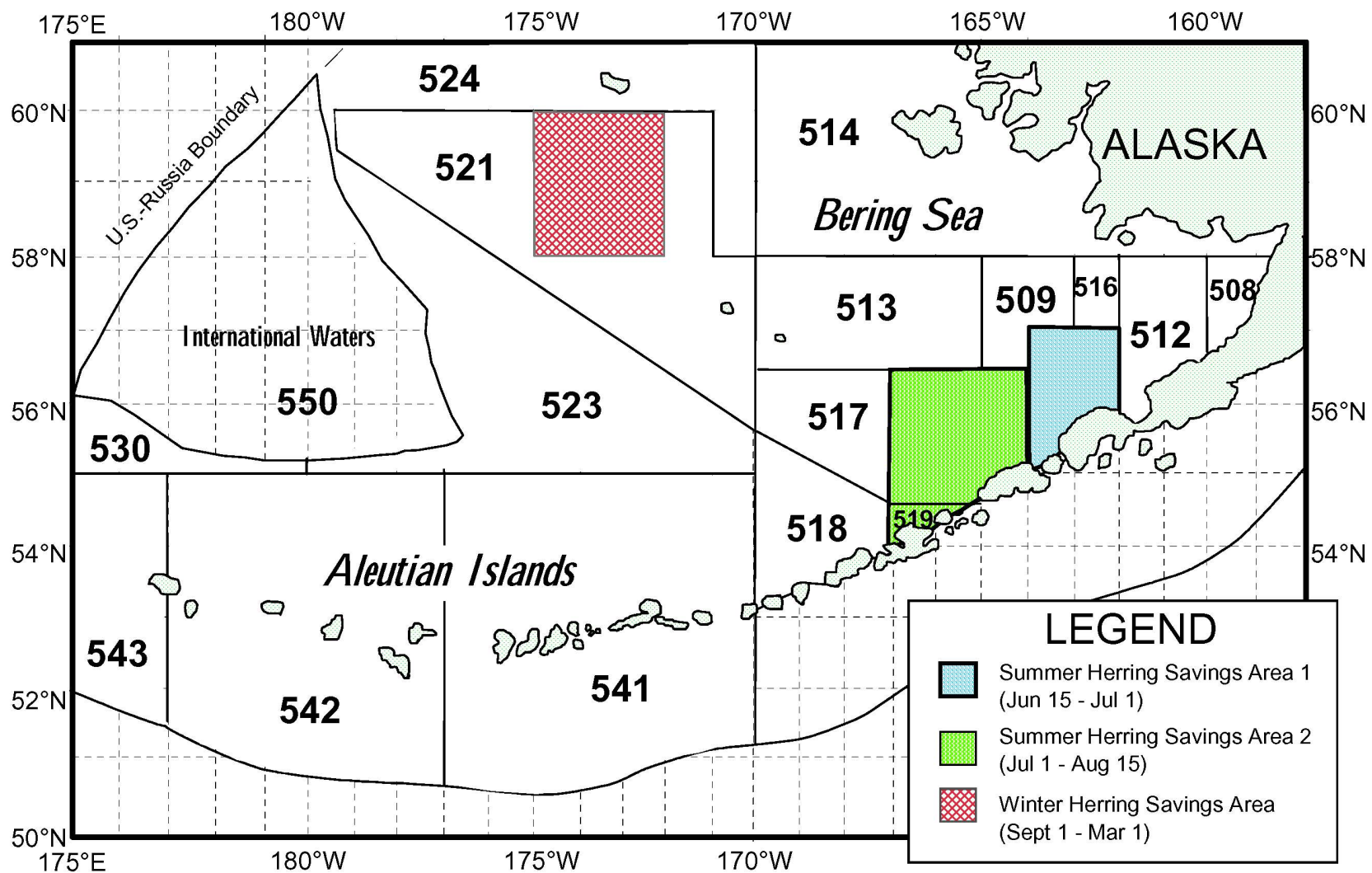


Figure 1 Herring Savings Areas 1, 2, and 3, located in the Bering Sea.

Crab bycatch in the BSAI is also managed through the use of seasonal time and area closures and PSC limits (BSAI Amendments 40 and 41). Bycatch limits for king and Tanner crabs are generally a function of crab abundance as estimated from annual trawl surveys conducted by NMFS (Table 6). Current PSC limits represent about 1 percent or less of the estimated annual abundance of each species. This fixed percentage approach means that annual PSC limits adjust in conjunction with increases or decreases in the underlying population. Bycatch limits are considered an acceptable loss rate that does not significantly deplete stocks or impede the recovery rates for rebuilding depleted stocks. BSAI Amendment 57, which prohibits the use of non-pelagic trawl gear in the BSAI pollock fishery, further reduces crabs bycatch limits as indicated in Table 5. PSC limits are also allocated among areas and target fisheries. When a PSC limit is reached for a specific fishery/area, that fishery is closed for the season. Most of the bycatch of crabs in the BSAI comes from directed trawl fisheries for yellowfin sole, rock sole, flathead sole, and Pacific cod.

**Table 6 Prohibited species bycatch limits for crabs in the BSAI. BSAI Amendment 57 further reduced bycatch.**

Species	PSC Limits	Abundance
Red king crab (Zone 1)	35,000 crabs (-3,000 additional crabs)	Less than 14.5 million lbs of female spawning biomass in eastern Bering Sea
	100,000 crabs (-3,000 additional crabs)	From 14.5 to 55 million lbs of female spawning biomass in eastern Bering Sea
	200,000 crabs (-3,000 additional crabs)	Greater than 55 million lbs of female
		spawning biomass in eastern Bering Sea
Opilio Tanner crab Bycatch Limitation Zone	0.1133% of total crab abundance	
	(-150,000 additional crabs)	
	Minimum: 4.5 million crabs	
	Maximum: 13 million crabs	
Bairdi Tanner crab	Zone 1 (-20,000 additional crabs)	
	0.5% of abundance	0-150 million crabs
	750,000 crabs	150-270 million crabs
	850,000 crabs	270-400 million crabs
	1,000,000 crabs	Over 400 million crabs
	Zone 2 (-30,000 additional crabs)	
	1.2% of abundance	0-175 million crabs
	2,100,000 crabs	175-290 million crabs
	2,550,000 crabs	290-400 million crabs
	3,000,000 crabs	Over 400 million crabs

There are no PSC limits or time and area closures for crabs in the GOA. Although the bycatch of crabs in the GOA is very small relative to those in the BSAI, there is little information on the sizes and status of GOA stocks. There is no way to determine the proportion of each stock being affected by bycatch nor if critical crab habitat is being damaged.

Of the two principal management tools used to control crab bycatch—PSC limits and time/area closures—PSC limits are probably the least effective. Crab bycatch in the trawl fishery is not a major source of crab mortality, relative to other sources of crab mortality such as the directed crab fishery. However, because trawling negatively impacts crab stocks through unobserved mortality and habitat degradation, closed areas tend to be more effective than PSC limits in reducing the impact of trawling on crab stocks (Witherell and Harrington 1996). The critical importance of crab habitat to the success of crab populations was the key element that prompted the Council to establish crab savings and conservation areas. These protected areas likely have a significant beneficial effect on the conservation of crab stocks in the BSAI.

## **Pacific Salmon**

Salmon and trout fisheries are managed under a mixture of both domestic and international regulations and treaties. Fisheries are managed by ADF&G within state waters, where most of Alaska's commercial fishing occurs. Commercial fishing within the EEZ is limited to southeast Alaska and Council management is deferred to ADF&G. Harvests of chinook, coho, and sockeye salmon in southeast Alaska are managed by agreement with Canada under the Pacific Salmon Treaty. Management of salmon fisheries in international waters of the Northern Pacific is under the auspices of the North Pacific Anadromous Fish Commission, a four-country body representing Canada, Japan, Russia, and the U.S.

Within the state of Alaska, ADF&G manages salmon stocks for individual rivers of origin based upon escapement (the number of surviving spawners). Most salmon return to their natal rivers of origin to spawn and this fidelity leads to reproductively distinct stocks within the overall population. Each year, spawners are counted during their upstream migration. This means that escapement estimates are made after stocks have been reduced by natural mortality at sea, bycatch at sea, and directed fisheries downriver. If the perceived number of surviving spawners in a given river is below management goals, ADF&G limits or prohibits fishing in Alaska's commercial, subsistence, and recreational fisheries. Stock management by the state thus compensates for groundfishing bycatch loss by reducing yields to directed salmon fisheries.

The five species of Pacific salmon are divided into two FMP bycatch management groups: chinook salmon, and "other" salmon (chum, sockeye, coho, pink). Steelhead trout have not been observed recently in either the BSAI or GOA and are not considered in this assessment. All groundfish fisheries in the BSAI and GOA are prohibited from retaining any species of salmon except for those retained under the Voluntary Salmon Donations Permit that authorizes their retention for local food banks (BSAI Amendment 26, GOA Amendment 29). In 1999, over 3 million pounds were donated.

Of the five salmon species, only the bycatch of chinook and chum salmon are of any serious concern in the BSAI and GOA. Pink, coho, and sockeye salmon populations in Alaska are considered healthy and bycatch in the groundfish fisheries represents only a minuscule portion of state harvests. These three species also are small components of bycatch in the groundfish fishery relative to chinook and chum salmon. The 926,879 Pacific salmon taken as bycatch in the BSAI from 1990 to 1997 consisted of 590,892 (64 percent) chum salmon, 331,759 (35 percent) chinook salmon, 3,557 (0.38 percent) coho salmon, 173 (0.02 percent) sockeye salmon, and 491 (0.05 percent) pink salmon. The 366,491 Pacific salmon taken as bycatch in the GOA from 1990 to 1997 consisted of 200,637 (55 percent) chum salmon, 160,264 (44 percent) chinook salmon, 3,952 (1.08 percent) coho salmon, 337 (0.09 percent) sockeye salmon, and 1,301 (0.35 percent) pink salmon. Most of these salmon are taken in pelagic trawl gear targeting pollock.

Although the overall bycatch of chinook and chum salmon is also very small relative to state harvests, bycatch take could pose a threat to specific stocks (rivers of origin). Some western stocks of chinook salmon are currently depressed. In 2000, there were fishing closures in the Yukon and Kuskokwim river systems and it is possible that ADF&G escapement goals may not be realized over the immediate future. If individual stocks become so depressed that full closure of direct fisheries is insufficient to enable a rebound in the population, then any additional mortality, including bycatch, could negatively impact the stock. It is estimated that 58-70 percent of chinook salmon bycatch in the BSAI groundfish fisheries may originate from western Alaska stocks, but it is unknown what proportion of these salmon are specifically from depressed

stocks. Analysts contend that there is insufficient information to determine the effects of BSAI bycatch and PSC limits on specific at-risk stocks within this western group.

The Council adopted BSAI Amendment 21b which established a PSC limit in the BSAI of 48,000 chinook salmon allocated between January 1 and April 15 for trawl gear. Upon attainment of the bycatch limit, all trawling was prohibited in the 9,000 nm<sup>2</sup> Chinook Salmon Savings Area (Figure 1). Chinook salmon bycatch tends to be high in this area during the January-April time frame. Trawl fisheries were reopened after April 16 for the remainder of the year. The PSC limit represents about 19.2 to 36.9 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. This is a substantial portion of the domestic harvest.

In 1999, the Council adopted BSAI Amendment 58 which 1) further reduced the chinook salmon bycatch limit from 48,000 to 29,000 fish by 2003, 2) implemented year-round accounting of chinook salmon bycatch in the pollock fishery, 3) revised the boundaries of the Chinook Salmon Savings Areas, and 4) set more restrictive closure dates. This reduced PSC limit represents about 11.6 to 22.3 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. Still a sizable proportion of the domestic harvest.

PSC limits have not been established for salmon in the GOA, however, seasonal fishing seasons for pollock in the central and western GOA have been adjusted to avoid periods of high chinook and chum salmon bycatch. Bycatch in the GOA groundfish fishery is presently only about 2-4 percent of directed chinook salmon landings in Alaska and is not likely to have an effect on populations in general. Western stocks are thought to make up a smaller proportion of chinook salmon bycatch than in the BSAI, however, there is insufficient information to determine how much smaller and what proportion may actually consist of specific at-risk stocks.

Some western Alaska stocks of chum salmon are also depressed. In the BSAI (BSAI Amendment 35), a limit of 42,000 "other" salmon (primarily chum salmon) can be taken between August 1 and September 1 in the 5,000 nm<sup>2</sup> Chum Salmon Savings Area (see Fig. 1). Analysts estimate that about 19 percent of chum salmon bycatch in the BSAI is from western stocks. Because this is equivalent to only 1.3 to 1.5 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999, bycatch represents a tiny fraction of landings even for depressed stocks. In all likelihood, bycatch of chum salmon in the BSAI has a negligible effect on Alaskan stocks. Further, there is considerable spatial overlap of the Chum Salmon Savings Area with the Stellar Sea Lion Conservation Area (SCA), which, under provisions of the AFA, greatly limits pollock fishing in that region of the Aleutian Islands.

There are currently no bycatch limits or area closures for "other" salmon in the GOA. From 1997 to 1999, chum salmon comprised about 56 percent (5,000 fish) of "other" salmon taken as bycatch in the GOA. This amount of bycatch was equivalent to 0.02-0.03 percent of all chum salmon landings and only 0.34-0.82 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999. Such low proportions suggest that chum salmon bycatch in the GOA will have little impact on any Alaskan stocks.

Although there are no salmon stocks in Alaska that are listed as either Endangered or Threatened under the Endangered Species Act (ESA), there are several listed stocks of chinook and chum salmon from rivers in Washington, Oregon, and California that could migrate into marine waters off Alaska. After detailed study, NMFS (1994) concluded, "the groundfish fisheries are not likely to jeopardize the continued existence of any ESA-listed salmon."

### 5.3 Forage Species

Direct fisheries for forage fish species are prohibited in the EEZ (BSAI Amendment 36, GOA Amendment 39). Forage species are permanently relegated to bycatch only status in the groundfish fishery. MRB limits are set at 2 percent for the entire group regardless of species composition. Fish taken within the 2 percent limit may be commercially retained and processed into fishmeal. In all cases, most of the forage fish bycatch is taken in pelagic trawls; 74 percent in the BSAI, 93 percent in the GOA. The vast majority of forage fish taken as bycatch are osmerids (capelin, eulachon, other smelts). Collectively, forage fish form only a small part of bycatch of groundfish fisheries typically comprising less than 1 percent of any directed harvests. From 1990 to 1993, osmerid bycatch ranged from 127.2 to 530.7 mt in the GOA, and from 31.8 to 292.1 mt in the BSAI. In the most recent three years, 1997 to 1999, an average of 39 mt of forage species were taken annually in the BSAI region and 61 mt in the GOA. Bycatch in the GOA was higher at 218 mt.

There are no biomass estimates for forage fish in the BSAI or the GOA and it is difficult to quantitatively determine the effect of bycatch on forage fish populations. For many forage fish species, little is known about their abundance, growth rates, maturity, migrations, and trophic relationships. Some of the more common forage fishes such as capelin, smelt, and eulachon are R-selected species (high reproductive rates, fast growth, rapid maturity) that may undergo considerable natural fluctuations in abundance. While this R-selective strategy may help stocks rebound quickly from depressed levels, variable abundance could make stock (impact) assessments that much more difficult.

Nevertheless, given the position that forage fish, particularly osmerids, occupy in the North Pacific ecosystem, it is unlikely that bycatch would have a significant effect on any of the forage fish species over time. The mere fact that forage fish play such a central role in the trophic chain, serving as food for a wide variety of fish, marine mammals, and seabirds, suggests that they must exist at biomass levels capable of sustaining such a vast biological system. Between the BSAI and GOA there are an estimated 48 million seabirds, nearly 230,000 seals and sea lions, a groundfish fishery that annually permits the harvest of 1.5-2.0 million mt of fish, a coastal halibut fishery that annually harvests nearly 60,000 mt, and an Alaskan salmon industry that in 1998, landed 154 million (330,000 mt) adult fish. The annual loss of a few hundred mt of forage fish is unlikely to have a significant effect on this system or forage fish stocks.

### 5.4 Other Species

Annual aggregate TAC limits are set for "other" species, and separately for squid in the BSAI, based upon stock assessments. Based upon 1999 stock assessments, the Council is considering an expanded FMP amendment that would specify TACs on individual species of sharks and skates. The Council has also recommended that "other" species be placed on bycatch only status. Decisions are pending.

There is some concern that under the current management plan a species or species group could be disproportionately exploited within the aggregate TAC. The "other" species category includes species with diverse life histories, and in many cases little is known about their population dynamics and structure. Species that are long-lived and have low reproductive potential are particularly vulnerable to depletion because it takes them longer to rebound from natural and fishing mortality. In addition to the paucity of life history data, a lack of research and fishing data also hampers assessments of stock status and bycatch effects. Individual species within the skate and sculpin complexes are not identified aboard ship because of a lack of trained personnel and time constraints. This greatly limits the value of any catch data. A lack of biomass estimates for squid precludes stock status relative to bycatch. All of these data limitations make it difficult to determine the extent to which individual species are protected from the pressures of bycatch given the aggregate TAC allocation. Current Council efforts to develop individual TACs and bycatch restrictions on individual taxa within the "other" species category could eventually prove beneficial to disproportionately exploited species should they exist.

## **5.5 Nonspecified Species**

There is currently no management or monitoring of any species in this category. Full retention of any "nonspecified" species is permitted under current FMP policy. The same concerns about disproportionate exploitation of certain species expressed above for "other" species is also germane to "nonspecified" species. Little is known about the ecology of many of the species in this category and no fishing data are recorded. For example, bycatch of grenadiers is higher in the GOA than all species in the "other" species category combined, yet the extent to which this bycatch may affect these long-lived species is unknown.

## **5.6 Indirect Effects**

### **5.6.1 Spatial and Temporal Concentrations in Bycatch**

Indirect impacts caused by spatial or temporal concentrations of bycatch might include the overharvesting of a distinct genetic component of a stock, local alterations in predator-prey relationships, or adverse impacts to spawning grounds or aggregations. In many instances, particularly with species within "other," nonspecified, and forage fish categories, so little is known about their population dynamics and life histories that it is difficult to determine the indirect impacts of the Status Quo. The dynamic nature of the North Pacific ecosystem would make assessments equally difficult even for more well understood fish species. Assessments would have to contend with a host of variables such as natural fluctuations in population size, migratory patterns, shifts in population age structures, and localized productivity. Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch.

### **5.6.2 Socioeconomic**

FMP management measures have had some level of success in decreasing overall bycatch mortality, but not without cost to the groundfish fishery. Halibut bycatch mortality limits have resulted in numerous closures over the years and have reduced the commercial catch of target species. Because of halibut PSC limits, portions of the annual TACs specified for most flatfish species have remained unharvested (Witherell 1995). Careful release requirements established for the long-line fishery have improved discard survival but have also increased the amount of time and effort expended by fishermen. Pacific herring PSC limits have repeatedly closed Herring Savings Areas 2 and 3 to trawl fisheries directed at pollock, rock sole, yellowfin sole, and other flatfishes. Area closures for salmon and crabs also impede commercial fishing efforts.

In general, many steps taken to reduce bycatch also reduce commercial harvests and/or the economic value of those harvests within the North Pacific groundfish fisheries. The extent of economic cost to the groundfish industry depends on a number of factors, the specifics of which are far beyond the scope of this overview.

Aside from promoting general conservation, protecting depressed species, and reducing waste, bycatch restrictions implemented for the groundfish industry confer positive economic benefits to nongroundfish fisheries. Regardless of the regulatory bodies involved, halibut, herring, and salmon fisheries are managed with the primary goal of maintaining healthy, productive, and sustainable populations that will support commercial, subsistence, and recreational fisheries over the long term. Population declines systematically trigger regulatory restrictions on fishing while population expansions allow for increased harvests. Over the long term, any reduction in bycatch (mortality) in the groundfish fishery would be offset by increased harvests in the other domestic fisheries. Whether the gain to domestic fisheries is substantial is a matter for more detailed economic analysis.

## **5.7 Cumulative Effects**

The current analysis has identified three ways in which FMP policy might affect the diversity or stability of the BSAI and GOA ecosystems: 1) altering biodiversity 2) affecting predator-prey relationships, and 3) altering energy flow.

### **5.7.1 Biodiversity**

Biological diversity (or biodiversity) is a general term that defines the diversity of life and its processes (CEQ 1993). Biodiversity may be expressed in terms of species diversity, functional (trophic) diversity, or genetic diversity. Measures of species diversity include the number of species in a community (species richness) and the relative abundance among species (evenness). Functional diversity deals with the stability and relative abundance among interdependent taxa within the trophic web. Genetic diversity is the inherent genetic heterogeneity within a species. Species characterized by greater genetic diversity are generally more capable of responding and adapting to physical and biological changes in their environment. The removal of fish through bycatch could disproportionately affect one species over another thereby disrupting the natural balance in species or trophic diversities. Removal of localized spawning aggregations could alter genetic diversity if the particular aggregation of fish removed from the system is genetically different from other components of the population.

At present, there is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of the alternative on biodiversity in terms of bycatch. Species characterized by long life spans, slow growth, late maturity, and/or low reproductive potential run the greatest risk of being depleted by bycatch removal. Whether the bycatch incurred under the Status Quo Alternative is sufficient to substantially impact vulnerable species having these characteristics is unknown. Bycatch mortality is generally considered to have a negative effect because of increased loss to the ecosystem; however, the magnitude and significance of this loss cannot be accurately assessed at this time.

Factors unrelated to the groundfish fishery are far more likely to be the principal agents driving species diversity in the region. These would include the introduction of non-indigenous species, natural fluctuations in the relative abundance of species within the food web, and long-term climatic changes. The potential changes caused by global climatic changes alone could potentially dominate the system regardless of any groundfish management plan.

### **5.7.2 Predator-Prey Relationships**

Predator-prey relationships can be altered by selectively removing predators or competing forage species from the food web, overfishing important forage species by concentrating fishing effort in time or space, removing top predators, or by introducing non-indigenous competitors into the food web. Given the natural and anthropogenic forces at work in the North Pacific, it seems unlikely that bycatch associated with the Status Quo policy have any significant effect on the predator-prey ecosystem overall. The external pressures exerted directly on predator-prey components of the food web by all of the directed fisheries operating in Alaskan and North Pacific would more than overwhelm any effect of bycatch. Compared to bycatch, the removals of predator and prey biomass associated with seasonal harvests of salmon, halibut, herring, groundfish, and crabs are massive.

At localized level, however, depletion of specific size or age groups could have short terms affects on predator-prey relationships. Such impacts might be difficult to detect. Their ramifications to the ecosystem are uncertain.

### **5.7.3 Ecosystem Energy Balance**

Fishing can remove energy (i.e., biomass) from an ecosystem. If sufficient energy is removed, or returned as discards, from the system relative to total biomass, the energy balance of the system could be destabilized or changed with unknown consequences. In fact, it is likely that anthropogenically-induced changes have already occurred in the North Pacific ecosystem given the long history of commercial and subsistence fishing in the region. Nevertheless, it is highly unlikely that bycatch loss associated with the Status Quo Alternative have significantly altered the energy characteristics of the BSAI and GOA. The amount of biomass being removed that is directly associated with these two components is minuscule compared to the biomass removal

that results from the combined commercial, subsistence, and recreational fisheries operating in Alaska and the North Pacific. Further, the ecosystem energy balance in the North Pacific is dynamic and in a constant state of flux in both time and space. Over time, the effect of bycatch removal and alterations of energy flow patterns associated with discarding of bycatch would be easily absorbed by such a massive oceanic system.

## **6.0 Alternative 2: Adopt a More Aggressive Management Policy**

### **6.1 Policy Goals and Objectives**

Under this alternative a more aggressive harvest strategy would be implemented. Details of policy goals and objectives are outlined in the section entitled Policy Alternatives and Rationale. Specific illustrative FMP measures for Alternative 2 are summarized in Table 3.

### **6.2 Direct Effects**

The overall effect of Alternative 2 would be a general increase in bycatch mortality for forage and PSC species and, in cases when TAC limits are exceeded, for target and "other" species. The severity of increased bycatch loss would depend upon the degree to which management policy would shift from the Status Quo (FMP Bookend 2.2) toward the opposite Alternative 2 extreme (FMP Bookend 2.1). The increase in bycatch would be further exacerbated by provisions in Alternative 2 which allows for an increase in TACs for the directed fisheries from current levels (FMP Bookend 2.2) all the way up to a projected 15-20 percent increase in fishing (FMP Bookend 2.1). The gradual repeal of time and area closures across the Alternative 2 policy spectrum could increase mortality within crab, herring, salmon, and halibut populations. The direct effect of Alternative 2 provisions on the different species groups and management tools are detailed below.

#### **6.2.1 Target Species**

Normally, rigorous management of directed fisheries would allow target stocks to endure higher mortality associated with bycatch regardless of the management measures adopted within the range offered under Alternative 2. Any increase in mortality would eventually be incorporated into stock assessments that are used by the Council and NMFS to set TAC limits for subsequent fishing seasons. However, the alternative also provides for a downsizing of the present observer program (FMP Bookend 2.2) up to its complete elimination (FMP Bookend 2.1). Because information collected by the observer program is crucial to stock assessments, its elimination means that targeted stocks may not be efficiently managed. The net affect could be quite detrimental to groundfish populations particularly given the increase in fishing pressure under the alternative.

A more aggressive harvest strategy could increase waste attributable to economic discards. Easing of the IR/IU program (detailed below) up to its full elimination under FMP Bookend 2.1 would almost certainly increase the number of pollock and cod discards. In the BSAI, the original implementation of the IR/IU program resulted in an immediate decrease in the discard rates for pollock from 94,800 mt to 16,200 mt, and for Pacific cod from 22,100 mt to 4,300 mt. A combination of phasing out of the program and increased fishing under Alternative 2 could result in pollock and cod discard rates notably higher than pre-IR/IU levels. The mandatory retention program currently scheduled to take effect under the Status Quo for selected species of flatfish would also be abandoned. Increased harvests of target species could result in proportionate increases in the number of economic discards (i.e., waste) in many of groundfish fisheries.

#### **6.2.2 Prohibited Species**

##### **Halibut**

The elimination of bycatch restrictions is not likely to have a significant biological impact on the halibut population over the long term regardless of the management measures adopted within the range offered under



Alternative 2. The halibut population is presently healthy and total catch has been near record levels. Any increase in bycatch would be incorporated into IPHC stock assessments and harvest quotas. Lower harvest quotas would offset increased bycatch loss. The net effect would be an economic loss to the directed halibut fisheries and an increase in waste attributable to bycatch discards.

## **Herring**

The Pacific herring population would be largely unaffected by increased bycatch mortality over the long term regardless of the management measures adopted within the range offered under Alternative 2. ADF&G adjusts annual harvest quotas relative to projected herring biomass in the BSAI and GOA. Lower harvests in the nearshore State fisheries would offset increased bycatch mortality. The net effect would be an economic loss to the directed herring fisheries and increased waste attributable to bycatch discards.

## **King and Tanner Crabs**

Crabs are the group most likely to be at long-term risk as the result of relaxed bycatch restrictions, particularly the elimination of time and area closures. Many of the crab stocks in the BSAI are currently at or below critical levels. As discussed under Alternative 1, agency analysts contend that the greater danger to crabs comes from trawls that disrupt essential crab habitat. Closed areas thus tend to be more effective than PSC limits in reducing the impact of trawling on crab stocks. If time and area closures and gear restrictions are lifted under Alternative 2, there is a real potential for damage to crab stocks in areas of high aggregation. It is a virtual certainty that the complete repeal of time area closures and gear restrictions that would be reached under FMP Bookend 2.1 would have serious detrimental consequences to crab stocks.

As was the case for Alternative 1, there is little information on the sizes and status of GOA stocks. There is no way to determine the proportion of each stock being affected by bycatch or if critical crab habitat is being damaged in any substantial way.

## **Pacific Salmon**

Under Alternative 2, PSC limits in the BSAI would be reduced from levels that currently exist under the Status Quo (FMP Bookend 2.2) toward their complete elimination (FMP Bookend 2.1). There are currently no bycatch restrictions in the GOA so no change would occur.

For the reasons described under Alternative 1, it is possible that current PSC restrictions in the BSAI management region may not be providing adequate protection to some depleted western chinook salmon stocks. If this is the case, the removal of PSC limits could exacerbate the situation and more at-risk chinook salmon might be taken. Further, the Status Quo PSC limit of 29,000 fish represents about 11.6 to 22.3 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. This is a substantial portion of the domestic harvest. Elimination of PSC limits would increase these proportions even further.

Western Alaska stocks of chum salmon are also depressed. Under Alternative 1, analysts estimate that about 19 percent of chum salmon bycatch in the BSAI is from western stocks and that this is equivalent to only 1.3 to 1.5 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999. This bycatch represents a tiny fraction of landings, even for depressed stocks. Under FMP Bookend 2.1, there might be a 15 to 20 percent increase in the harvests of target species, which could result in a proportionate increase in chum salmon bycatch throughout the entire BSAI. This would still be equivalent to only a small fraction of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999.

Current PSC restrictions on chum salmon are limited to the catcher vessel operation area where 42,000 "other" salmon can be taken between August 15 and October 15, a period when chum salmon bycatch in the trawl pollock fishery is very high. Even if the PSC limit were lifted, pollock fishing in the Savings Area

would be limited by seasonal allocations of TAC which, under Alternative 2, remain the same as the Status Quo. Further, there is considerable spatial overlap of the chum salmon Savings Area with the SCA, which, under provisions of the newly passed AFA, greatly limits pollock fishing in that region of the Aleutian Islands. It is unlikely that the removal of the PSC limits and increased pollock TAC would seriously affect at-risk western chum salmon stocks.

As discussed under Alternative 1, the bycatch of sockeye, coho, and pink salmon are insignificant in the BSAI and GOA relative to seasonal harvests in directed Alaskan fisheries. The bycatch of ESA-listed salmon stock for Washington, Oregon, and California are also nominal. These stocks would remain unaffected regardless of the management measures adopted within the range offered under Alternative 2.

### **6.2.3 Forage Species**

Alternative 2 would affect the bycatch of forage fish in two ways: 1) the gradual repeal of bycatch restrictions would mean the elimination of 2 percent MRB limits for forage fish, and 2) the gradual increase in groundfish fishing effort could result in a proportionate increase in bycatch.

In most instances, the bycatch for forage fish is far less than 1 percent in any of the targeted fisheries. From 1997 to 1999, the proportionate bycatch of forage fish relative to the total target fish harvest was <0.01 percent in the BSAI and 0.39 percent in the GOA. When averaged over the fishery, bycatch was well below MRB limits. If these trends are indicative of long-term bycatch trends in the groundfish fishery, then easing of the 2 percent cap, up to its full elimination under FMP Bookend 2.1, is not likely to substantially increase bycatch overall simply because the MRB limits are not normally reached anyway when averaged over the entire fishery. Because bycatch rates are so low, even an increase in harvest under Alternative 2, up to a maximum increase of 15-20 percent that would occur under FMP Bookend 2.1, is not likely to substantially increase the bycatch of forage fish. For the reasons discussed under Alternative 1, it is unlikely that bycatch would seriously impact forage fish stocks regardless of the management measures adopted within the range offered under Alternative 2.

There is a provision under Alternative 2.2 for the establishment of a directed fishery for forage fish. Although the effects of a directed fishery is a TAC and not a bycatch issue, increased fishing pressure on any of the targeted species that would accompany such a measure could require re-evaluation of bycatch loss, particularly on a localized scale.

### **6.2.4 Other Species**

The management of "other" species under Alternative 2 is the same as for the Alternative 1 Status Quo. Although the "other" species group is currently managed as an aggregate, the Council has proposed that TACs and bycatch restrictions be developed on an individual species basis for skates and rays. It is assumed that additional species may be singled out as additional information is gathered. Any enhanced focus on individual species within the "other" species category could eventually prove beneficial to disproportionately exploited species, should they exist.

### **6.2.5 Unspecified Species**

Under the Status Quo, there is currently no management or monitoring of any species in this category. Little is known about the ecology of many of the species and it is difficult to assess the effects of this policy. No additional protection would be offered this group under Alternative 2. As with Alternative 1, there is insufficient information on the species within this group with which to assess the potential effects of the plan.

### **6.2.6 Observer Program**

The alternative provides for a downsizing of the present observer program (FMP Bookend 2.2) up to its complete elimination (FMP Bookend 2.1). The observer program serves a crucial role in gathering data

essential for monitoring bycatch in the groundfish fishery. Any reduction in the observer program would impede the effectiveness of what is essentially the onsite eyes and ears of the entire fisheries management system. Record keeping and reporting requirements mandated by the Council for operational fishing vessels provide some essential management information, but they do not provide the kinds of detailed and independent catch data that is supplied by onboard observers. A repeal of the program could have a significantly negative effect on bycatch management and, in turn, the health and stability of all groundfish stocks.

#### **6.2.7 Improved Retention/Improved Utilization**

The alternative ranges from maintaining the present IR/IU program (FMP Bookend 2.2) up to its complete repeal (FMP Bookend 2.1). In 1998, the year the amendment was implemented, discards in the BSAI dropped by 77 mt for pollock and 17,800 mt for pacific cod compared to the previous year. Relaxation of the 100 percent retention policy up to full repeal would allow for a corresponding increase in number of economic discards. As discussed above under Target Species, pollock and cod populations are managed via stringent stock assessment models and TAC allocations, and discard losses are taken into account when determining yearly harvest quotas. The presence or absence of an IR/IU program would have no effect on stocks. However, the elimination of the IR/IU program would increase waste by permitting more economic discards. The mandatory retention program currently scheduled to take effect under the Status Quo for selected flatfish species would also be abandoned. Waste associated with economic discards would continue.

#### **6.2.8 Vessel Incentive Program**

There are no proposed changes in the Vessel Incentive Program that is currently implemented under the Alternative 1 Status Quo.

### **6.3 Indirect Effects**

#### **6.3.1 Spatial and Temporal Concentrations in Bycatch**

Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch (see Spatial and Temporal Concentrations in Bycatch under Alternative 1).

#### **6.3.2 Socioeconomic**

The primary benefit of Alternative 2 would be an economic boost to the groundfish industry at the expense of other fisheries (e.g., halibut, herring). The plan would gradually open the North Pacific to a less restrictive fishing environment and allow for larger and more economically-efficient harvests. Fishing would still be limited by management strategies to maximize the sustainable yields of targeted stocks but fishing efforts would be less encumbered by bycatch restrictions. Halibut PSC limits alone typically prevent the full harvest of most other flatfish species. Virtually all herring bycatch occurs in the pollock fishery—the largest groundfish fishery in Alaskan waters.

The degree of economic benefit is problematic and would depend on a number of factors including the costs and benefits of extended fishing seasons, fishing seasons less constrained by specific time or area allocations, and the voluntary retention of marketable species. Some fisheries would benefit more than others. Pollock occur primarily in well defined aggregations and if fishing fleets encounter a hot spot they may be able to "top off" their seasonal TAC allocation rapidly (cost effectively) and with minimal bycatch. Some flatfish species that are more widely dispersed may be more costly to harvest even without bycatch restrictions.

The economic advantage conferred on the groundfish industry by Alternative 2 would come at the expense of other domestic fisheries in the region. Decreased fishing effort in the domestic fisheries would compensate

for increased bycatch mortality in the groundfish fishery. Whether the economic loss to domestic fisheries would in any way be substantial is a matter for economic analysis.

## **6.4 Cumulative Effects**

### **6.4.1 Biodiversity**

There is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of the alternative on biodiversity. Factors unrelated to the groundfish fishery are far more likely to be the principal agents driving species diversity in the region (see Biodiversity under Alternative 1).

### **6.4.2 Predator-Prey Relationships**

In general, it is unlikely that the increased bycatch that would occur under Alternative 2 would have any significant effect on the predator-prey ecosystem (see Predator-Prey Relationships under Alternative 1). At localized level, however, depletion of specific size or age groups could have short term effects on predator-prey relationships. Such impacts might be difficult to detect and their ramifications difficult to ascertain.

### **6.4.3 Ecosystem Energy Balance**

It is unlikely that the increase in bycatch loss associated with the alternative will have a significant effect on the energy budgets of the BSAI and GOA (see Ecosystem Energy Balance under Alternative 1).

## **7.0 Alternative 3: Adopt a More Precautionary Management Policy**

### **7.1 Policy Goals and Objectives**

Under this alternative a more precautionary harvest strategy would be implemented. Details of policy goals and objectives are outlined in the section entitled Policy Alternatives and Rationale. Specific Illustrative FMP measures for Alternative 3 are summarized in Table 3.

### **7.2 Direct Effects**

The overall effect of Alternative 3 would be a general decrease in bycatch mortality for forage and PSC species and, in cases when TAC limits are exceeded, for target and other species. The extent of bycatch reduction would depend upon the degree to which management policy would shift from a moderately more restrictive bycatch policy (FMP Bookend 3.1) to a substantially more restrictive bycatch policy (FMP Bookend 3.2). Bycatch could further be reduced by provisions in Alternative 3 which would decrease TACs in the directed fisheries from current Status Quo levels (FMP Bookend 3.1) to levels that have yet to be determined under TAC provisions outlined under FMP Bookend 3.2. Lower TAC settings for the directed fisheries would contribute to lower bycatch. More stringent management of individual species groups within the "other" and nonspecified categories would allow for more precise control of bycatch mortality and their effects on stocks. Expanded time and area closures would offer enhanced protection to crab, herring, salmon, and halibut populations. The direct effects of Alternative 3 provisions to the different species groups and management tools are detailed below.

#### **7.2.1 Target Species**

Under a more restrictive management policy, fishing effort and harvests would decrease throughout the groundfish fishery. Change in the bycatch of a target species and adjustments in gear restrictions and allocations are not likely to have a significant effect on that population. Because bycatch mortality is

incorporated into stock assessments that are used by the Council and NMFS to set TAC limits for subsequent fishing seasons, any benefits conferred on the target species by lower bycatch would eventually be offset by higher harvests in the directed groundfish fishery for that species.

### **7.2.2 Prohibited Species**

#### **Halibut**

More stringent bycatch restrictions and a more limited directed groundfish fishery are not likely to have a significant biological impact on the halibut population over the long term regardless of the management measures adopted within the range offered under Alternative 3. Any decrease in bycatch mortality would be incorporated into IPHC stock assessments and harvest quotas. Any benefit conferred on the halibut population by lower bycatch would eventually be offset by higher harvests in the directed halibut fishery. The directed halibut fishery would incur positive economic benefits at the expense of the groundfish fishery.

#### **Herring**

The Pacific herring population would be unaffected by more stringent bycatch restrictions and a more limited directed groundfish fishery over the long term regardless of the management measures adopted within the range offered under Alternative 3. ADF&G adjusts annual harvest quotas in State domestic fisheries based upon herring stock projections. Any benefit conferred on the herring population by lower groundfish fishery bycatch would eventually be offset by higher harvests in the directed State fisheries. Economic benefits would accrue to the herring fishery at the expense of the groundfish fishery.

#### **King and Tanner Crabs**

Under Alternative 3, PSC limits in the BSAI could be lowered from 0-10 percent (FMP Bookend 3.1) to 10-30 percent (FMP Bookend 3.2). PSC limits would be established for the GOA based upon stock and fishery data, then lowered 0-10 percent. Time/area/gear closures in the BSAI would remain consistent with the Status Quo. Appropriate closures would be implemented in the GOA based upon scientific study.

As discussed under Alternative 1, closed areas tend to be more effective than PSC limits in reducing the impact of trawling on crab populations. Nevertheless, PSC limits, per se, would help curtail bycatch mortality. Maintaining closures in the BSAI would continue to have a significantly beneficial effect on crab stocks. The development of appropriate closures in the GOA could similarly be beneficial to crab populations in that region.

#### **Salmon**

Under Alternative 3, PSC limits in the BSAI would be lowered to the extent practical from 0-10 percent (FMP Bookend 3.1) to 10-30 percent (FMP Bookend 3.2). In the GOA, PSC limits would be established at 25,000 fish for chinook and 20,500 fish for other salmon. Because salmon stocks in Alaska are rigorously managed by ADF&G and are generally considered healthy, any benefit conferred by lower bycatch would eventually be offset by higher harvests in the State's commercial, subsistence, and recreational fisheries. Economic benefits would accrue to these fisheries. Any additional protection afforded salmon populations under Alternatives 3 would, therefore, have no long-term effect on stock status.

The possible exceptions are at-risk western stocks of chinook salmon that may be taken as bycatch in the BSAI (see Alternative 1). At present, there is insufficient information with which to determine if these at-risk stocks are being seriously impacted by bycatch in the BSAI under the Status Quo. It would be equally difficult to quantitatively determine if increased protection offered under Alternative 3 would be sufficient to protect these stocks from further depletion. Qualitatively, reduced PSC limits ranging from 0-10 percent under FMP Bookend 3.1 to 10-30 percent under FMP Bookend 3.2 should offer proportionate protection to at-risk western chinook salmon stocks.

Alternative 3 would establish blanket PSC limits (FMP Bookend 3.1 to FMP Bookend 3.2) of 25,000 chinook salmon and 20,500 "other" salmon in the GOA. Since there is no indication that salmon stocks of any species are being adversely affected by the current absence of PSC limits in the GOA, it is unlikely that additional protection would have any effect on salmon populations.

### **7.2.3 Forage Fish**

For the reasons outlined for Alternative 1, the bycatch of forage fish under the Status Quo is not likely to have an effect on forage fish stocks. Additional reductions in bycatch under Alternative 3 would, therefore, provide no additional benefit to forage fish populations.

### **7.2.4 Other Species**

Alternative 3 includes measures that would break sharks and skates out of the "other" species category and establish individual TACs for each. The Council would also have the choice, based upon available scientific information, of removing the remaining species groups (sculpin, octopi, and GOA squid) from the "other" species category and likewise managing them via individual TACs (FMP Bookend 3.2). Enhanced focus on individual species or species groups would provide for a more rigorous management of stocks both in terms of TAC and possible bycatch restrictions. Such measures could offer greater protection to species that are disproportionately exploited under the current aggregate management plan if they indeed are at risk.

### **7.2.5 Unspecified Species**

Alternative 3 would seek to develop criteria to bring nonspecific species into a managed category. Because little is known about the population dynamics of many of the species in this category, it is difficult to assess the effects of this policy. However, the establishment of management practices typically promotes directed research toward specific species or species groups. This could enhance the Council's understanding of population dynamics for species within this group and result in greater protection for stocks that may currently be at risk from unregulated bycatch take.

### **7.2.6 Observer Program**

Alternative 3 calls for an expansion in the observer program from the Alternative 1 Status Quo (FMP Bookend 3.1) to complete coverage of all vessels greater than 60 ft in length (FMP Bookend 3.1). The current FMP management plan requires 100 percent coverage on vessels greater than 124 ft, but only 30 percent coverage on vessels ranging from 60 to 124 ft in overall length. An expanded observer program could only enhance the ability of the Council and NMFS to monitor and regulate bycatch in the groundfish fishery. The key issue would be the cost of implementing such an expanded program.

### **7.2.7 Improved Retention/Improved Utilization**

The provisions under Alternative 3 are the same as under the Alternative 1 Status Quo.

### **7.2.8 Vessel Incentive Program**

Under Alternative 3, the current Vessel Incentive Program would be replaced with a number new conservation measures. Most options would include granting harvest and PSC priorities to parties who practice clean fishing standards that result in the reduction of discards. Individual bycatch standards would be established. Although these programs may be worthwhile conservation measures, the reduction in discards would not likely affect any managed species since any savings would eventually be offset by higher harvests in directed fisheries.

## **7.3 Indirect Effects**

### **7.3.1 Spatial and Temporal Concentrations in Bycatch**

Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch (see Spatial and Temporal Concentrations in Bycatch under Alternative 1).

### **7.3.2 Socioeconomic**

The primary impact of Alternative 3 would be to increase the economic burden on the groundfish industry. The plan would implement a more restrictive fishing environment and result in less economically efficient harvests. The degree of economic loss is a matter for economic analysis and would depend on a number of factors including the costs and benefits of more restricted fishing seasons, and fishing seasons more constrained by specific time/area allocations and closures. Some fisheries would be impacted more than others.

A more restricted groundfish industry would benefit other domestic fisheries in the region. Halibut, herring, and salmon fisheries are managed with the primary goal of maintaining healthy, productive, and sustainable populations that will support commercial, subsistence, and recreational fisheries over the long term. Reduced bycatch mortality and discard waste in the groundfish fishery would eventually be realized as higher yields in domestic fisheries. Whether the gain to domestic fisheries would in any way be substantial is a matter for detailed economic analysis.

## **7.4 Cumulative Effects**

### **7.4.1 Biodiversity**

There is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of Alternative 3 on biodiversity. Factors unrelated to the groundfish fishery are far more likely to be the principal agents driving species diversity in the region (see Biodiversity under Alternative 1).

### **7.4.2 Predator-Prey Relationships**

It is highly doubtful that decreased bycatch associated with Alternative 3 will have any significant effect on the predator-prey ecosystem (see Predator-Prey Relationships under Alternative 1).

### **7.4.3 Ecosystem Energy Balance**

It is highly unlikely that the decrease in bycatch loss associated with the alternative will have a significant effect on the energy budgets of the BSAI and GOA (see Ecosystem Energy Balance under Alternative 1).

## **8.0 Alternative 4: Adopt a Highly Precautionary Management Policy**

### **8.1 Policy Goals and Objectives**

Under this alternative an extremely precautionary harvest strategy would be implemented. Details of policy goals and objectives are outlined in the Policy Alternatives and Rationale section. Specific Illustrative FMP measures for Alternative 4 are summarized in Table 3.

## **8.2 Direct Effects**

The overall effect of Alternative 4 would be a major decrease in bycatch mortality for most forage and PSC species and, in cases when TAC limits are exceeded, for target and "other" species. More stringent management of individual species groups within the "other" and nonspecified categories would allow for more precise control of bycatch mortality and their effects on stocks. A greater prevalence of time and area closures would offer enhanced protection to crab, herring, salmon, and halibut populations. Protections would be maximized under FMP Bookend 4.2 which would close the groundfish fishery altogether. The direct effect of Alternative 4 provisions to the different species groups and management tools is detailed below.

### **8.2.1 Target Species**

Under a more restrictive management policy, fishing effort and harvests would decrease throughout the groundfish fishery. Any change in the bycatch of a target species is not likely to have a significant effect on that population. Because bycatch mortality is incorporated into stock assessments that are used to set TAC limits for subsequent fishing seasons, any benefits conferred on the target species by lower bycatch would eventually be offset by higher harvests in the directed groundfish fishery for that species. Decreased harvests and an IR/IU program for all target species could substantially reduce waste attributable to economic discards. FMP Bookend 4.2 would eliminate all bycatch. It would also eliminate the fishery.

#### **Halibut**

More stringent bycatch restrictions and a more limited directed groundfish fishery are not likely to have a significant biological impact on the halibut population over the long term regardless of the management measures adopted within the range offered under Alternative 4. Any decrease in bycatch mortality would be incorporated into IPHC stock assessments and harvest quotas. Any benefit conferred on the halibut population by lower bycatch would eventually be offset by higher harvests in the directed halibut fishery. The directed halibut fishery would incur positive economic benefits at the expense of the groundfish fishery.

#### **Herring**

The Pacific herring population would be unaffected by more stringent bycatch restrictions and a more limited directed groundfish fishery regardless of the management measures adopted within the range offered under Alternative 4. ADF&G adjusts annual harvest quotas in State domestic fisheries based upon herring stock projections. Any benefit conferred on the herring population by lower groundfish fishery bycatch would eventually be offset by higher harvests in the directed State fisheries. The directed herring fishery would see positive economic benefits at the expense of the groundfish fishery.

#### **King and Tanner Crabs**

Under Alternative 4, PSC limits in the BSAI would be lowered to the extent practical from 30-50 percent (FMP Bookend 4.1) to PSC = 0, the complete closure of the fishery (FMP Bookend 4.2). In the GOA, PSC limits would be established based upon biomass and fisheries data, then lowered 30-50 percent. Additional closures would be established for the BSAI and GOA (FMP Bookend 4.1) and expanded to full closure of all crab habitats (FMP Bookend 4.2).

As discussed under Alternative 1, closed areas tend to be much more effective than PSC limits in reducing the impact of trawling on crab populations. Thus, the effect of more restrictive PSC limits is problematic unless those limits trigger area closures. Expanding closures in the BSAI and GOA would provide added protection to crab stocks. The closure of the groundfish fishery under FMP Bookend 4.2 would maximize this protection.



## **Salmon**

Under Alternative 4, PSC limits in the BSAI would be lowered to the extent practical from 30-50 percent (FMP Bookend 4.1) to PSC = 0, or the closure of the fishery (FMP Bookend 4.2). In the GOA, PSC limits would be established at 25,000 fish for chinook and 20,500 fish for other salmon (FMP Bookend 4.1) and would remain in effect until complete closure of the fishery (FMP Bookend 4.2). Because salmon stocks in Alaska are rigorously managed by ADF&G and are generally considered healthy, any benefit conferred by lower bycatch would eventually be offset by higher harvests in the State's commercial, subsistence, and recreational fisheries. Domestic fisheries would benefit economically at the expense of the groundfish fishery.

The possible exceptions are at-risk western stocks of chinook salmon that may be taken as bycatch in the BSAI. There is insufficient information with which to determine if these at-risk stocks are being seriously impacted by bycatch in the BSAI under the Status Quo. Likewise, it is difficult to quantitatively determine if decreased bycatch under FMP Bookend 4.1 would sufficiently protect these stocks. Unless improved stock assessment and identification methods are developed, the no fishing provision under FMP Bookend 4.2 is the only measure that would guarantee full protection to at-risk western chinook salmon stocks.

### **8.2.2 Forage Fish**

For the reasons outlined for Alternative 1, the bycatch of forage fish under the Status Quo is not likely to have an effect on forage fish stocks. Additional reductions in bycatch under Alternative 4 would, therefore, provide no additional benefit to forage fish populations.

### **8.2.3 Other Species**

Alternative 4 would set the TAC of species complexes within the "other" species category based upon the least abundant member of the group. It is assumed that any management strategy focusing on TACs could ultimately affect bycatch restrictions for that group. It is also assumed that the "least abundant" criterion is based upon the idea that least abundant, or rare, species are somehow at greater risk and that management strategy should center on protecting these most vulnerable stocks. While rare species may be more vulnerable to fishing pressures, sufficient scientific information would need to be gathered to verify such a conclusion for any given case. Low abundance of a particular "other" species could merely be the result of the directed fishery operating outside the primary distribution range of that species. Nevertheless, a more restrictive fishing policy could offer greater protection to species that are disproportionately exploited under the current aggregate management plan.

### **8.2.4 Unspecified Species**

The FMP Bookend 4.2 extreme is a complete fishing ban; i.e., TAC = 0 for all species. Because little is known about the ecology of many of the species in the "unspecified species" category it is difficult to assess the effects of this policy. However, a no fishing alternative would completely eliminate the possibility of any unspecified species being overfished as bycatch.

### **8.2.5 Observer Program**

Alternative 4 would expand observer coverage from 30 percent to 100 percent on all vessels 60-124 ft in length, and from 0 percent to 30 percent on all vessels less than 60 ft in length. It would also require that 100 percent of the hauls be observed. An expanded observer program could only enhance the ability of the Council and NMFS to monitor and regulate bycatch in the groundfish fishery. The key issue would be the cost of implementing such an expanded program.

### **8.2.6 Improved Retention/Improved Utilization**

Alternative 4 calls for an expansion of the IR/IU program to all target species (FMP Bookend 4.1) up to the full prohibition on bycatch (FMP Bookend 4.2) which is effectively a no fishing alternative. Any expansion of the 100 percent retention policy would allow for a corresponding decrease in number of economic discards for all target species. Because target species are managed via stringent stock assessment models and TAC allocations, a reduction in discards would be taken into account when determining yearly harvest quotas. Any benefit conferred on target species would eventually be offset by higher harvests in the directed groundfish fisheries. Expansion of the IR/IU program up to a full prohibition on fishing would likely have no significant effect on groundfish stocks but would decrease waste. Full retention might also cause boats to top off sooner, which could result in shorter trips and less take overall.

### **8.2.7 Vessel Incentive Program**

There are no proposed changes in the Vessel Incentive Program as currently implemented under the Alternative 1 Status Quo.

## **8.3 Indirect Effects**

### **8.3.1 Spatial and Temporal Concentrations in Bycatch**

Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch (see Spatial and Temporal Concentrations in Bycatch under Alternative 1). FMP Bookend 4.2 would completely shut down the groundfish fishery and render the issue moot.

### **8.3.2 Socioeconomic**

The primary impact of Alternative 4 would be to increase the economic burden on the groundfish industry. The plan would implement a more restrictive fishing environment and result in less economically efficient harvests. The degree of economic loss is a matter of economic analysis and would depend on a number of factors including the costs and benefits of more restricted fishing seasons, and fishing seasons more constrained by specific time/area allocations and closures. Some fisheries would be impacted more than others. FMP Bookend 4.2 would completely shut down the groundfish fishery.

A more restricted groundfish industry or its elimination would benefit other domestic fisheries in the region. Reduced bycatch mortality in the groundfish fishery would eventually be realized as higher yields in domestic fisheries. Whether the gain to domestic fisheries would in any way be substantial is a matter for economic analysis.

## **8.4 Cumulative Effects**

### **8.4.1 Biodiversity**

There is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of the alternative on biodiversity. Factors unrelated to the groundfish fishery such as introduction of non-indigenous species, natural fluctuations in the relative abundance of species within the food web, and long-term climatic changes are far more likely to be the principal agents driving species diversity in the region (see Biodiversity under Alternative 1).

### **8.4.2 Predator-Prey Relationships**

It is highly doubtful that decreased bycatch associated with Alternative 4, even up to the point of eliminating the groundfish fishery, will have any significant effect on the predator-prey ecosystem (see Predator-Prey Relationships under Alternative 1).

### **8.4.3 Ecosystem Energy Balance**

It is highly unlikely that the decrease in bycatch loss associated with Alternative 4 will have a significant effect on the energy budgets of the BSAI and GOA (see Ecosystem Energy Balance under Alternative 1).

## **9.0 Opportunities for Quantification**

The most likely species for which quantitative impact assessments of bycatch can be made are those high profile groups that are the subject of major directed fisheries in Alaska and the North Pacific. These would include Pacific halibut, Pacific herring, Pacific salmon (with selected exceptions), king and tanner crab (in the BSAI), and target groundfish species such as walleye pollock, Pacific cod, and yellowfin sole or any other species managed under Tiers 1-3. Because of their inherent economic value, these species are typically the subject of the most intense research and monitoring efforts and, therefore, are the species for which the most comprehensive scientific information is available. The irony is that because these stocks are some of the most rigorously managed, they are the least vulnerable to losses attributable to bycatch. Any increase or decrease in bycatch would ultimately be offset by increased or decreased harvests in the directed fishery. Management effectively buffers the populations from the effects of bycatch. The major exceptions are crabs, in which loss or a gain in critical habitat under the different alternatives could tangibly affect stock health.

A second group for which nominal qualitative data may be available, or cost effectively compiled, is forage fish. While the forage fish category comprises eight fish families and euphausiid shrimp, the vast majority of fish taken as bycatch in the BSAI and GOA groundfish fisheries are osmerids (eulachon, capelin, and other smelts). Non-osmerids are, therefore, not a serious bycatch issue. Recent declines in North Pacific seabird populations have prompted research into the health and status of regional forage fish stocks that are such an important food source for seabirds. Because osmerids are R-selected (high reproductive rates, fast growth, rapid maturity), populations tend toward wide fluctuations in abundance. Nevertheless, even coarse estimates of osmerid abundance and predator biomass based upon Alaska Fisheries Science Center (AFSC) and Council/NMFS sponsored research, might be adequate to determine whether the bycatch loss of several mt of forage fish is truly detrimental to the North Pacific food web.

## **10.0 Data Gaps and Information Needs**

There is very little scientific information available on the biology and ecology of individual species within the "other" species and "nonspecified" species categories. There is concern that species within these groups might be disproportionately impacted by losses attributable to bycatch. This is particularly true for long-lived species with low reproductive potential that are less resilient to fishing pressures. "Other" species are presently managed with an aggregate TAC and there is no way to determine if individual species are being overfished relative to their population level. Unspecified species may be taken without restriction. The Council is presently trying to develop individual TACs and bycatch restrictions on individual taxa within the "other" species category in an attempt to protect vulnerable species. However, any realistic management plan will require more research into the population structure and community dynamics of individual taxa. One cost-effective approach to the problem would be to prioritize species based upon their presumed risk. For example, bycatch of grenadiers is higher in the GOA than all species in the "other" species category combined. This alone would make this species a prime candidate for further research.

There is little information on the degree to which at-risk western stocks of chinook salmon have been affected by bycatch in the BSAI. Yukon and Kuskokwim river stocks are seriously depleted. Low stock sizes

have resulted in reduced harvests that have seriously impacted Alaskan domestic fisheries in recent years. Excess bycatch in the groundfish fishery could further jeopardize these populations. The Council has responded by adopting Amendment 58 which will (1) reduce the chinook salmon bycatch limit to 29,000 fish over a four-year period, (2) implement year-round accounting of chinook salmon bycatch in the pollock fishery, (3) revise the boundaries of the Chinook Salmon Savings Areas, and (4) set more restrictive closure dates. Future responses to localized salmon stock depletions could be enhanced through a comprehensive (genetic) stock identification program, which would allow for more precise identification and management of salmon populations. A stock identification program would be mutually beneficial to state and federal interests and, as such, would likely require a joint effort encompassing ADF&G, AFSC, NMFS, the Council, and Academia. A cost/benefit appraisal would first be required.

Obtaining the biological data needed to enhance bycatch management of "other" and "nonspecified" species would likely require a protracted research effort by NMFS and AFSC. Given the number of taxa involved, species of interest or concern would need to be prioritized in terms of their importance to the ecosystem, their potential vulnerability to impact, the cost-effectiveness of obtaining the data required to manage individual species, and a determination would have to be made as to whether the resources are available to obtain such data. That determination would require detailed assessments by AFSC, NMFS, and the Council.

## **11.0 Comparative Analysis of Alternatives**

The three groundfish fishery management alternatives to the Status Quo call for a more aggressive harvest strategy (Alternative 2), a more precautionary harvest strategy (Alternative 3), and an extremely precautionary harvest strategy (Alternative 4). In terms of the direct effects of bycatch and discard waste on individual fish populations, none of these alternatives is likely to have a significant impact on target groundfish species, Pacific halibut, Pacific herring, forage fish species, coho salmon, sockeye salmon, pink salmon, chum salmon, nor any North Pacific salmon stock currently listed as endangered or threatened under the ESA. Being the targets of directed fisheries, target groundfish and PSC (halibut, herring, salmon) species are rigorously managed to ensure that populations remain healthy and robust over time. Losses to the population resulting from directed harvests far outweigh any loss attributable to bycatch. Further, any increase/decrease in bycatch or discard loss that might occur under any of the alternatives would be offset by harvest allocation adjustments within the targeted fishery.

The exception to the above is the fate of target species under Alternative 2.0 which provides for a downsizing of the present observer program (FMP Bookend 2.2) up to its complete elimination (FMP Bookend 2.1). Because information collected by the observer program is crucial to stock assessments, its elimination means that targeted stocks may not be efficiently managed. The net affect could be quite detrimental to groundfish populations particularly given the increase in fishing pressure which would also occur under the alternative.

The bycatch of forage fish under all of the alternatives, including the Status Quo, is presumed to be only a small fraction of North Pacific stocks, and none of the alternatives would likely impact these populations although local depleted would have to be considered.

The two species groups that are the targets of directed fisheries and which could be directly affected by the alternatives are king and Tanner crabs, and depleted western stocks of chinook salmon. Crab and chinook salmon stocks are currently depressed, which makes them more vulnerable to fishing impacts. The more aggressive harvest strategy of Alternative 2 could remove some of the protections that are offered these stocks under the Status Quo. Crabs are particularly vulnerable to benthic trawl disturbances and any repeal of area closures could seriously affect localized crab stocks. Conversely, added protection under alternatives 3 and 4 could increase protection to these at-risk populations.

The projected impact of the three alternatives on "other" and "unspecified" species can only be considered speculative. Little is known about the life histories and population dynamics of many of the species within these groups, and this makes it difficult to assess the effects of bycatch on individual stocks. There is concern that bycatch may disproportionately exploit and possibly deplete individual species, but the extent to which

this might occur under the Status Quo or any of the alternatives is unknown. Because the species within the "other" and "unspecified" categories are not targets of directed fisheries, bycatch is the principal source of fishing mortality. Since Alternative 2 would generally relax bycatch restrictions, its impact to "other" and "unspecified" species would conditionally be considered adverse simply because more fish would be lost as bycatch. Conversely, Alternatives 3 and 4 would be considered conditionally beneficial merely because of the generally reduced levels of bycatch. The expanded observer programs under the latter two alternatives would also enhance bycatch management for all species.

The indirect and cumulative effects of the different bycatch alternatives are also difficult to predict. Under Alternative 2, increased spatial or temporal concentrations of bycatch could overharvest distinct genetic components of a stock, alter local predator-prey relationships, change biodiversity, and/or adversely impact spawning grounds or aggregations. However, the dynamic nature of the North Pacific ecosystem and the complex interaction of physical and biological forces that drive and influence that system make it extremely difficult to assess the long-term effect of localized impacts, whether they be adverse or beneficial. Factors unrelated to the bycatch are far more likely to be the principal agents governing species diversity, food webs, and marine energy budgets in the region. Over the long term, the potential changes caused by global climatic shifts alone are likely to dominate the North Pacific ecosystem regardless of any groundfish management plan.

Economic effects of the different bycatch alternatives might be substantial. The more restrictive bycatch limitations implemented under Alternatives 3 and 4 would place greater economic burdens on the groundfishing industry. Harvest quotas would be more difficult to achieve and would require greater expenditures of time and money. The FMP Bookend 4.2 would eliminate the groundfish industry. Any economic benefits would go to other directed fisheries (e.g., halibut, herring, salmon) by allowing them to eventually realize any reduction in bycatch loss as increased harvests. Conversely, under Alternative 2, the groundfish fishery would operate in a less restrictive, more economically-efficient atmosphere with higher permissible bycatch loss. Other directed fisheries would have to compensate for that loss by lowering harvest quotas. Whether these economic tradeoffs would be substantial is a matter for economic analysis. Alternative 2 might also have geopolitical implications. Increased bycatch losses (i.e., lower nongroundfish harvests) might be incompatible with management goals mandated by international treaties and agreements.

**Bycatch FMP Summary Table**

<b>EFFECT INDICATOR</b>	<b>Alternative 1.0</b>	<b>Alternative 2.0</b>		<b>Alternative 3.0</b>		<b>Alternative 4.0</b>	
	<b>FMP 1.0</b>	<b>FMP 2.1</b>	<b>FMP 2.2</b>	<b>FMP 3.1</b>	<b>FMP 3.2</b>	<b>FMP 4.1</b>	<b>FMP 4.2</b>
<b>Direct Biological</b>							
Target Species	None: Managed fishery	Adverse: elimination of observer program compromises ability to manage stocks	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery
<b>Prohibited Species</b>							
Halibut	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery
Pacific Herring	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery
Pink, Sockeye,	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery	None: Managed fishery
Coho Salmon	General: none, managed fishery	General: none, managed fishery	Same as Alt. 1.0	General: none, managed fishery	General: none, managed fishery	General: none, managed fishery	General: none, managed fishery
Chinook and Chum Salmon	At-risk BSAI stocks: unknown	At-risk BSAI stocks: adverse; less protection than Alt. 1.0		At-risk BSAI stocks: beneficial; more protection than Alt. 1.0	At-risk BSAI stocks: beneficial; more protection than Alt. 3.1	At-risk BSAI stocks: beneficial; more protection than Alt. 3.2	At-risk BSAI stocks: beneficial; eliminate bycatch
King and Tanner	BSAI: beneficial; area closures protect crab habitat, PSC limits lower mortality	BSAI: adverse; easing of area closures that protect crab habitat, eliminate PSC limits	Same as Alt. 1.0	BSAI: beneficial; stricter PSC limits than Alt. 1.0	BSAI: beneficial; stricter PSC limits than Alt. 3.1	BSAI: beneficial; increase area closures and stricter PSC limits than Alt. 3.2	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries
Crab	GOA: unknown, insufficient data	GOA: unknown insufficient data		GOA: beneficial; develop management measures	GOA: beneficial; develop management measures	GOA: beneficial; establish area closures and PSC limits	
Forage Species	Adverse effect unlikely	Adverse effect unlikely establishment of a direct forage fish fishery may require re-evaluation of localized bycatch loss	Adverse effect unlikely	Adverse effect unlikely	Adverse effect unlikely	Adverse effect unlikely	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries

**Bycatch FMP Summary Table (Cont.)**

<b>EFFECT INDICATOR</b>	<b>Alternative 1.0</b>	<b>Alternative 2.0</b>		<b>Alternative 3.0</b>		<b>Alternative 4.0</b>	
	<b>FMP 1.0</b>	<b>FMP 2.1</b>	<b>FMP 2.2</b>	<b>FMP 3.1</b>	<b>FMP 3.2</b>	<b>FMP 4.1</b>	<b>FMP 4.2</b>
Other Species	Unknown: increased management focus potentially beneficial, enhanced species protection	Same as Alt. 1.0	Same as Alt. 1.0	Beneficial: increased management focus relative Alt. 1.0, enhanced species protection	Beneficial: increased management focus relative Alt. 1.0, enhanced species protection	Beneficial: increased management focus relative Alt. 1.0, enhanced species protection	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries
Nonspecified Species	Unknown: unmanaged	Same as Alt. 1.0	Same as Alt. 1.0	Beneficial: increased management focus relative Alt. 1.0 potentially beneficial, enhanced species protection	Beneficial: increased management focus relative Alt. 1.0 potentially beneficial, enhanced species protection	Beneficial: increased management focus relative Alt. 1.0 potentially beneficial, enhanced species protection	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries
<b>Management</b>							
Observer program	Beneficial: monitoring enhances management	Adverse: elimination detrimental to management	Adverse: downsizing detrimental to management	Beneficial: expanded coverage relative Alt. 1.0, enhances management Consideration: cost	Beneficial: expanded coverage relative Alt. 3.1, enhances management Consideration: cost	Beneficial: expanded coverage relative Alt. 3.2, enhances management Consideration: cost	Irrelevant; temporary elimination of bycatch; Beneficial for authorized fisheries enhances management
IR/IU	Beneficial: decrease discards (waste)	Adverse: elimination increases discards (waste)	Same as Alt. 1.0	Same as Alt. 1.0	Same as Alt. 1.0	Beneficial: expanded program decreases discards (waste)	Irrelevant; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries
VIP	Marginally beneficial	Same as Alt. 1.0	Same as Alt. 1.0	New programs considered, possibly beneficial in reducing waste	New programs considered, possibly beneficial in reducing waste	New programs considered, possibly beneficial in reducing waste	Irrelevant; temporary elimination of bycatch; Beneficial in reducing waste for authorized fisheries

**Bycatch FMP Summary Table (Cont.)**

<b>EFFECT INDICATOR</b>	<b>Alternative 1.0</b>	<b>Alternative 2.0</b>		<b>Alternative 3.0</b>		<b>Alternative 4.0</b>	
	<b>FMP 1.0</b>	<b>FMP 2.1</b>	<b>FMP 2.2</b>	<b>FMP 3.1</b>	<b>FMP 3.2</b>	<b>FMP 4.1</b>	<b>FMP 4.2</b>
<b>Indirect</b>							
Spatial/Temporal Concentrations	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Irrelevant: no fishery
Socioeconomic	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries	Adverse: non-groundfish fisheries Beneficial: groundfish fisheries	Adverse: non-groundfish fisheries Beneficial: groundfish fisheries	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries	Adverse: groundfish fisheries (no fishery) Beneficial: non-groundfish fisheries
<b>Cumulative</b>							
Biodiversity	Unknown: influenced more by factors unrelated to bycatch	Unknown: influenced more by factors unrelated to bycatch	Unknown: influenced more by factors unrelated to bycatch	Unknown: influenced more by factors unrelated to bycatch	Unknown: influenced more by factors unrelated to bycatch	Unknown: influenced more by factors unrelated to bycatch	Unknown: influenced more by factors unrelated to bycatch
Predator-Prey	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact
Relationship	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown
Ecosystem Energy	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact	General: no adverse impact
Balance	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown	Localized: unknown



## 12.0 Literature Cited

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